AD-A107 676 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CA --ETC F/G 10/2
TWO POINT FOUR KW DC/DC CONVERTER REGULATOR.(U)
OCT 81 R E EGGERT DAAB07-78-C-2988
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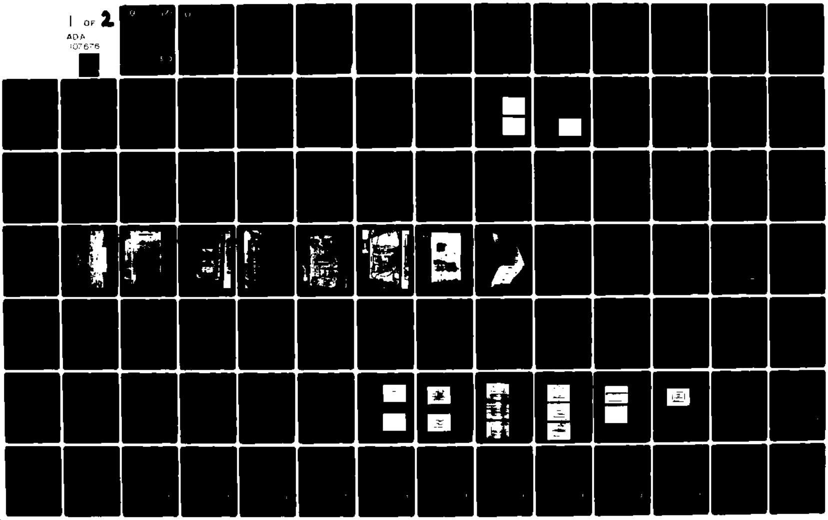

LEVEL

Research and Development Technical Report

DELET-TR-78-2988-F

AD A107 319

TWO POINT FOUR KW DC/DC CONVERTER REGULATOR

R.E. Eggert
TRW Defense & Space Systems Group
Power Conversion Electronics Department
Redondo Beach, CA 90278

October 1981

Final Report for Period October 1978 to October 1981

DISTRIBUTION STATEMENT

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ELECTRONICS TECHNOLOGY & DEVICES LABORATORY

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FORT MONMOUTH, NEW JERSEY 07703

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DELET-TR-78-2988-F	2. GOVT ACCESSION NO. AD-A107	3. RECIPIENT'S CATALOG NUMBER 276
4. TITLE (and Subtitle) TWO POINT FOUR KW DC/DC CONVERTER REGULATOR		5. TYPE OF REPORT & PERIOD COVERED FINAL REPORT October 1978 to April 1981
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. E. Eggert		8. CONTRACT OR GRANT NUMBER(s) DAAB07-78-C-2988
9. PERFORMING ORGANIZATION NAME AND ADDRESS TRW Defense & Space Systems Group Power Conversion Electronics Department Redondo Beach, CA 90278		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 1F263702DG11-02-013
11. CONTROLLING OFFICE NAME AND ADDRESS USA Electronics Technology & Devices Lab(ERADCOM) ATTN: DELET-PE Fort Monmouth, New Jersey 07703		12. REPORT DATE OCTOBER 1981
		13. NUMBER OF PAGES 84
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release;
distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Power Processor
DC-DC Conversion
Power Conversion
Converters
Power Conditioning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The 2.4KW DC-DC Converter/Regulator Power Module furnishes 0-75ADC over an output voltage range of 24 to 32VDC from a nominal 20-40VDC unregulated power source and can be used for battery charging from 5 to 75A. Remote output voltage sensing at the load circuit is provided to eliminate the IR drops of the power distribution cabling between the power module and the load.

A series inductor/parallel inverter power stage is used to provide the output power control and regulation input/output ground isolation and protection

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20. Abstract - (cont'd)

of the switching power transistors. The power supply is contructed in accordance with the Shelter-installed, Mobile C-E Equipment destined for shelter or van use without the fans used for cooling. The internal electronics are modularized according to circuit function with provision for easy removal or repair.

Reliability, efficiency, weight and size achieved are approximately 13,868 hours (MTBF), 85, 84.6 lbs., 1.96 cu. ft., respectively.

NOTICES

Disclaimers

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

FORWARD

The author wishes to acknowledge the contribution to this work by the Army Project Monitor, Mr. Larry Groehl whose thorough review, comments and suggestion helped to improve the technical results.

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1. INTRODUCTION.

The U.S. Army Electronics Research & Development Command is developing standardized power processing modules for application in the different power subsystem configurations being planned for digital equipment in communications, data handling, surveillance, and weapon systems. This report presents the results of work performed under contract DAAB07-78-C-2988 for the U.S. Army Electronics Research & Development Command to develop and manufacture two DC-DC Power Processor Development Units.

The original demonstration model of the DC-DC Power Processor was developed under contract DAAB07-75-C-1324 in 1976. The fundamental design concept employed is the same under both contracts. The goals under this contract were to improve the Thermal and Electromagnetic Interface Designs and to evaluate; (1) a new power transistor to improve its switching characteristics to reduce its losses and; (2) an improved filter capacitor to control ripple characteristics at low operating temperature.

The specific objective of this contract was the development and manufacture of two developmental power processors that would provide precise, transient free, adjustable 24 to 32V, 75A output power from a 20-40 volt unregulated input voltage bus. To improve the reliability and performance; and reduce development, production, and logistic costs.

The basic power stage design is the same as that employed under the DAAB07-75-C-1324 contract. The basic feature of the power stage in this design, is the power inductor which has two windings, one in series with the power source and the parallel inverter power transformer center tap and the second winding in parallel with the output filter capacitor. During the on-time of the power transistors, the difference between the input source and the power transformer is stored in the inductor primary winding and during the off-time of the power transistor, the energy stored in the inductor is transfered directly to the output filter.

1. INTRODUCTION-(Cont'd)

A complete 2.4kW DC-DC converter regulator was designed, breadboarded, and tested, using the new power transistor and improved filter capacitor. It was made in such a way as to simulate the final units, in order to evaluate the EMI Design. The complete electrical design was packaged to fit into a 19 inch rack panel.

The DC-DC Power Processor was packaged into a Type 1-Sheltered Equipment with the following dimensions.

- Front Panel 19 x 10.5 inches. (48.3 x 26.7 cm)
- Main Chassis 17 inches (43.2 cm) deep

  With a total weight of 84.6 lbs. (38.1 kg)

2. DESIGN PHILOSOPHY AND THEORY OF OPERATION.

As in the previous (6.2) development contract, the series Inductor/ Parallel Inverter power stage is employed here. A brief discussion is presented in order to understand the circuit operation and the current and voltage waveforms on each of the main circuit components.

2.1 Power Stage.

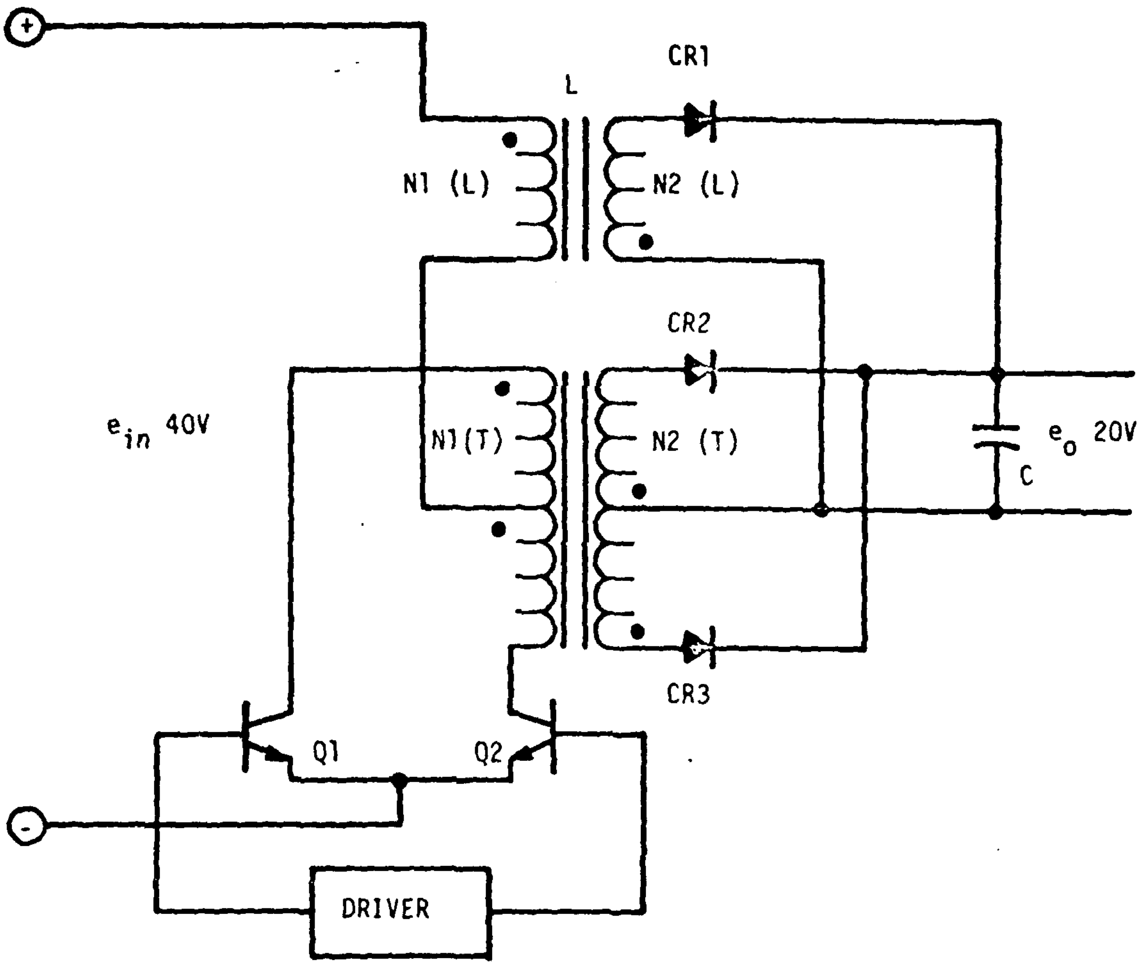
Figure 1 is the schematic for the series inductor parallel inverter power stage. The circuit includes the series inductor L with a primary and secondary winding, power transformer T, power transistor Q1 and Q2, output rectifiers CR1, CR2 and CR3 and output filter capacitor C. The power transistors are controlled by a driver stage to provide the correct pulse width & pulse position modulation to satisfy the input/output voltage requirements. In this example, both the inductor and transformer turns ratios are assumed to be one.

Figure 2 presents the transformer voltage, inductor voltage, power transistor Q1 current and voltage, power transistor Q2 current and voltage, and rectifier CR1, CR2 and CR3 currents. One complete cycle is presented in Figure 2, Q1 ON, Q1 & Q2 OFF, Q2 ON and Q1 and Q2 OFF. The example assumes 40 VDC input and 20 VDC output.

When Q1 is on, the 40 volt supply voltage is across the series inductor and power transformer. The change in the power transistor current I is due to the flux swing of inductor L ($E = -L\frac{di}{dt}$). This same current magnitude is flowing in the output diode CR2 to the output load and filter capacitor. The impressed voltages across transistor Q2 is equal to 40 volt ($2 \times E_o$).

When Q1 turns off, the energy stored in inductor L is supplied directly to output filter capacitor through output diode CR1. The impressed voltage across the power transistors is $\underline{E}$ in plus EN1 (L) and equals 60V.

When transistor Q2 is turned on and turned off, the same type of waveform exists as during the transistor Q1 operation.



ASSUME N1 (L) = N2(L) & N1(T) = N2T

$e_{in} = 40V$

$e_o = 20V$

FIGURE 1 SCHEMATIC-SERIES INDUCTOR/PARALLEL INVERTER POWER STAGE

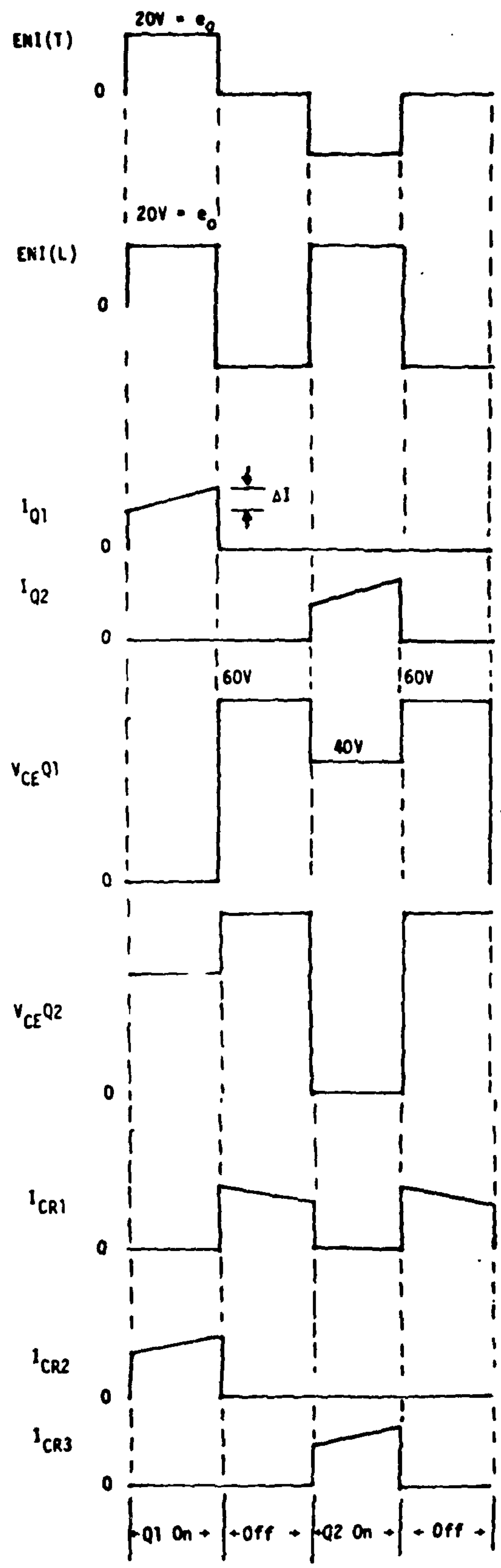


FIGURE 2 SERIES INDUCTOR/PARALLEL INVERTER WAVEFORM

2.1 Power Stage - (cont'd).

It is interesting to note the basic difference of the transistor voltages in the power stage configuration as shown in Figure 2 when compared with a conventional parallel inverter. When transistor Q1 is turned ON, the voltage across Q2 equals $2 \times e_{in}$ vs. $2 \times e_0$ as in this configuration. When transistor Q1 is turned OFF, the voltage across Q2 equals e_{in} vs. $e_{in} + e_0$ as in this configuration. The net effect is that the peak voltage stress is reduced to 75% of the conventional design configuration.

The basic advantages of this power stage configuration are: (1) lower peak voltage stress on the power transistor; (2) the series inductor always provides an impedance in series with the power transistor and therefore, has inherent current limit during output short, power transformer saturation and overlap of the power transistor Q1 and Q2.

The penalty of the design is that inductor L is about 50% larger due to having two windings instead of one in the conventional circuit and that an additional output diode is required.

The improved reliability due to the reduced voltage stress and current limiting greatly offsets the slight increase in the weight of the inductor and the addition of an extra power diode.

The next section will explain in detail the phase displacement, output load sharing and control techniques for output voltage regulation and output current limiting.

2.2 BLOCK DIAGRAM - DC TO DC POWER PROCESSOR.

The Block Diagram of the DC to DC Power Processor is shown in Figure 3.

The input DC power (20-40V) is supplied into an input EMI Filter, input circuit breaker and input power filter. The DC power is then distributed to the four power modules (two on each side panel). The power modules consists of four identical series inductor/parallel inverters. Each one of which handles 1/4 of the total input power.

2.2 BLOCK DIAGRAM - DC TO DC POWER PROCESSOR-(Cont'd)

The output from each power stage goes to a common output filter, output shunt, output circuit breaker, and output EMI Filter.

Each power stage includes a series power inductor, power transformer and push/pull power transistors. The power transistors are driven by a proportional current drive by means of a digital signal from the control logic. The control logic receives signals from the feedback control system ring counter, input DC line voltage and instantaneous transformer primary current and generates the correct digital control logic for the push/pull power transistor.

The control logic contains a flip-flop that turns the two power transistors on and off. The on time is initiated by a signal from the ring counter. The turnoff is initiated by the volt-second control in the control logic or via the primary peak current sensor.

The volt second control senses the input voltage and provides a constant volt-sec of energy to go into the power inductor and output transformer. The volt-sec control in each power module is pre-selected in test, so that, all power modules are carrying 1/4 of the total output power. By this means, no additional electronics are required to cause load sharing.

The peak current sensor constantly monitors the power transformer primary current and therefore, the power transistor collector current initiates a turn off if the instantaneous peak current is beyond a pre-determined threshold limit. This action provides inherent transistor protection during all transient and steady state modes of operation.

A common output voltage regulator and voltage divider/remote sense network monitor the output dc voltage in conjunction with the AC signal from the output filter, determines an output voltage to the voltage-to-frequency oscillator that commands the turn-on of the four separate phase displaced power modules through the ring counter.

2.2 BLOCK DIAGRAM - DC TO DC POWER PROCESSOR. (Con't)

The remote sense circuit is configured in such a way as to prevent loss of control, if the sense leads are opened or short-circuited or reversed across the output to be controlled.

The net output voltage of the error amplifier provides a voltage level to the voltage-to-frequency oscillator which is the heart of this control system. Therefore, all power modules operate at the same frequency. The frequency is proportional to the input amplified error voltage.

The power module phase displacement is controlled by the ring counter which senses sequential pulses to each of the four power modules to initiate the power transistor turn-on.

The signal from the output shunt and current regulator over-rides the voltage regulator and reduces the overall operating frequency of the voltage-to-frequency oscillator during overload operations.

Front panel adjustments are provided to allow for the 24 to 32VDC output voltage adjustment and for the 0 to 75A output current limit.

The output of the voltage-to-frequency oscillator is processed through an isolation transformer that isolates the output power ground from the input power ground and commands the ring counter to provide the correct duty cycle of the four separate power modules.

An undervoltage/overvoltage sensor monitor the DC input voltage and can inhibit the ring counter operation during abnormal input line condition (less than 20V and greater that 40VDC).

The undervoltage circuit can be disabled normally and is not recommend for use with power supplies with poor load regulation ($\geq$10% no load to full load) as unwanted cycling may occur at the undervoltage trip circuit. Instructions for providing this function are provided.

The front panel meter can monitor the DC output voltage or the DC output current.

Control electronics power is obtained from the main DC input voltage through a fuse to a control electronics DC-DC Converter. The control electronics DC-DC converter provides +10 and +5V output which is common with the input power ground and a +10V and 21V outputs for the output voltage and current regulators.

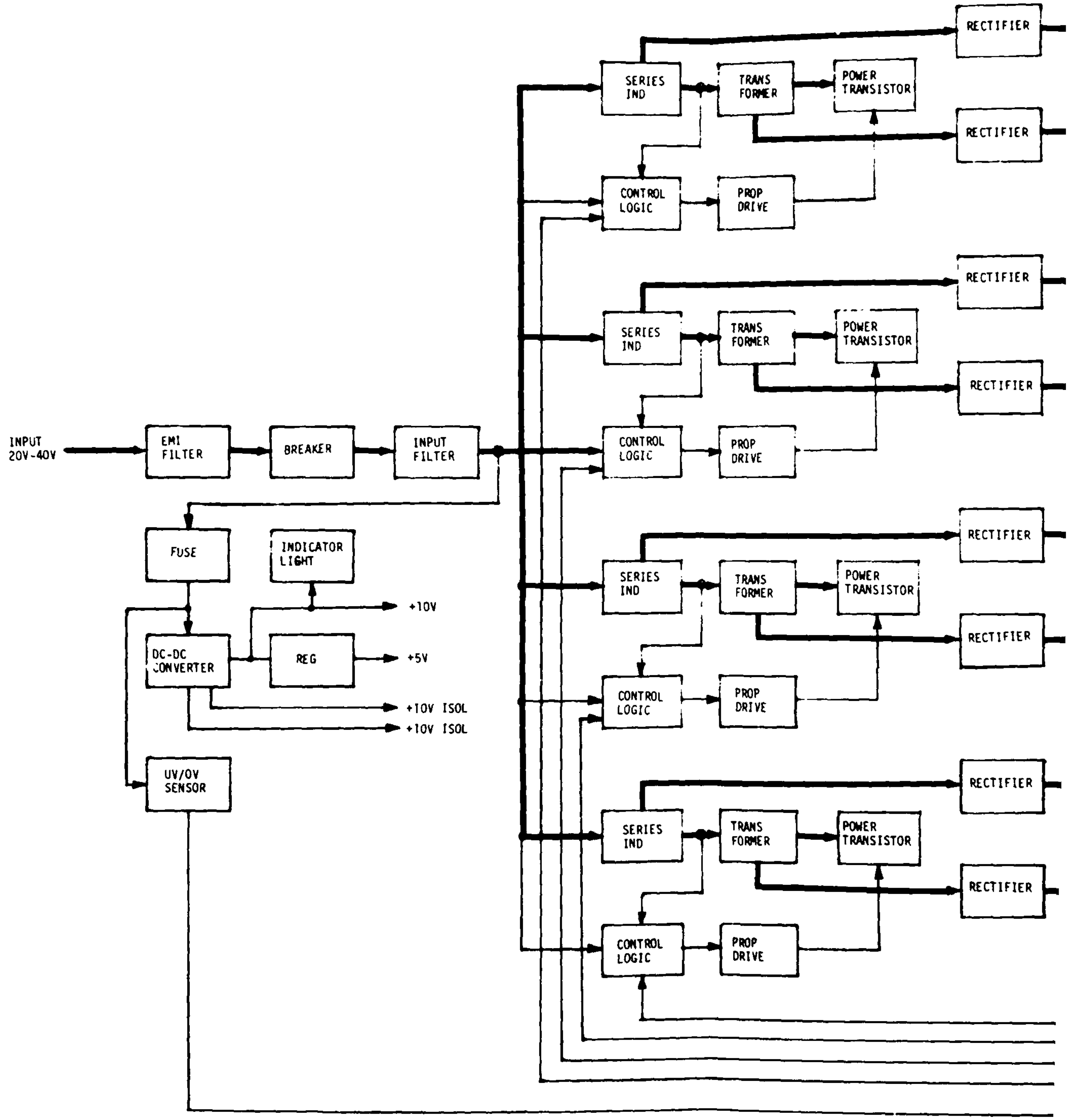
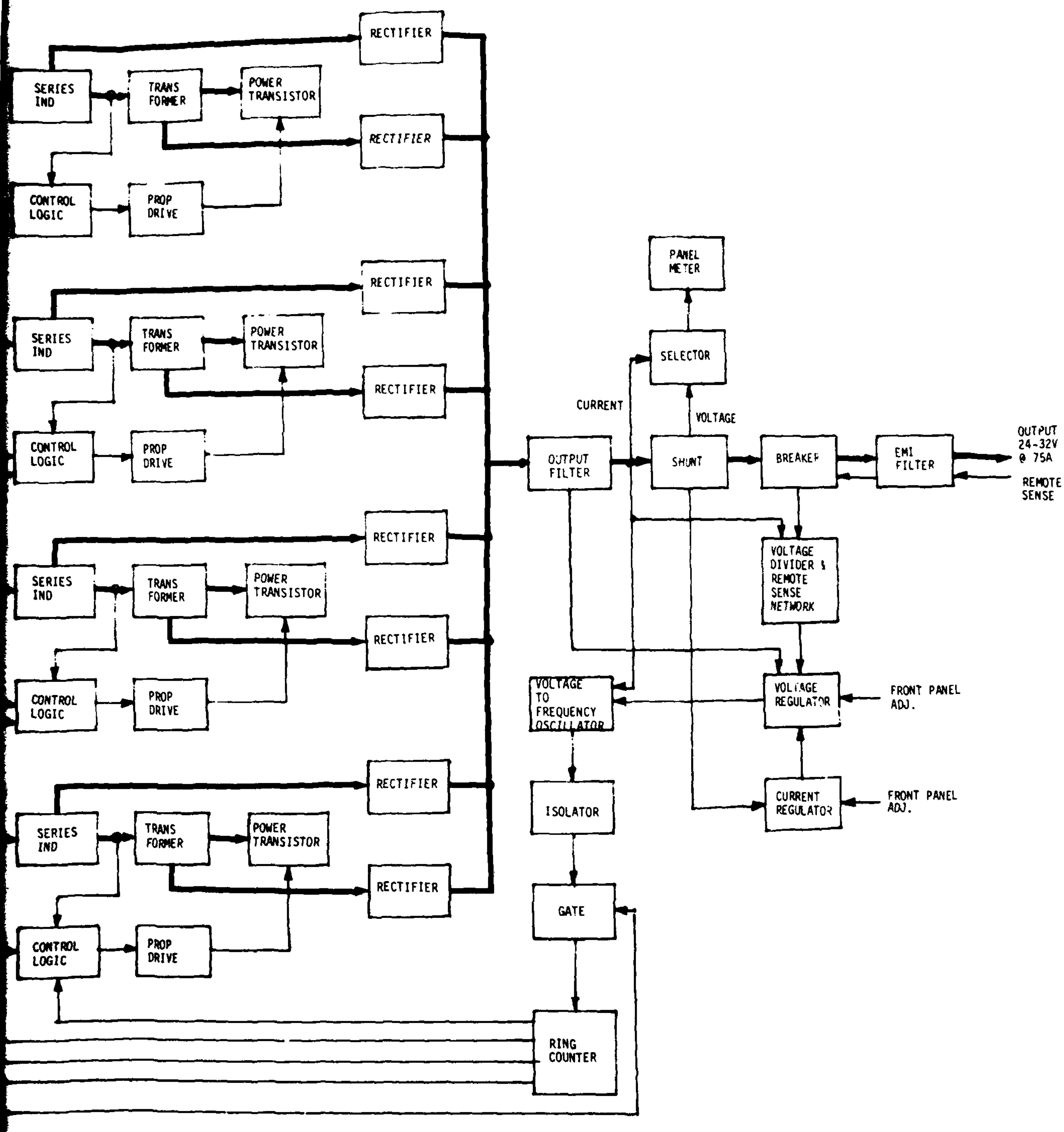


FIGURE 3 BLOCK DIAGRAM FOR THF 2.4KW DC-DC



URE 3 BLOCK DIAGRAM FOR THE 2.4KW DC-DC CONVERTER/REGULATOR

2.3 Component Considerations.

Power Transistor

An improved power transistor was employed in this design. This modification to the design allowed a single transistor to be used in place of the parallel transistors employed in the original developmental model.

The transistor used is the Solitron #55EJ105. The advantages of this transistor are:

- It switches faster.
- Has lower saturation voltages.
- Better thermal design.

Filter Capacitor

One common capacitor was used in both stages of the input filter and for the output filter capacitors.

This capacitor is a 2800μF 150VDC capacitor MEPCO/ELECTRA, INC. 91F series, aluminum Electrolytic, computer grade capacitor.

Its advantages are very low, equivalent series resistance which is maintained at low temperature, i.e., -55°C.

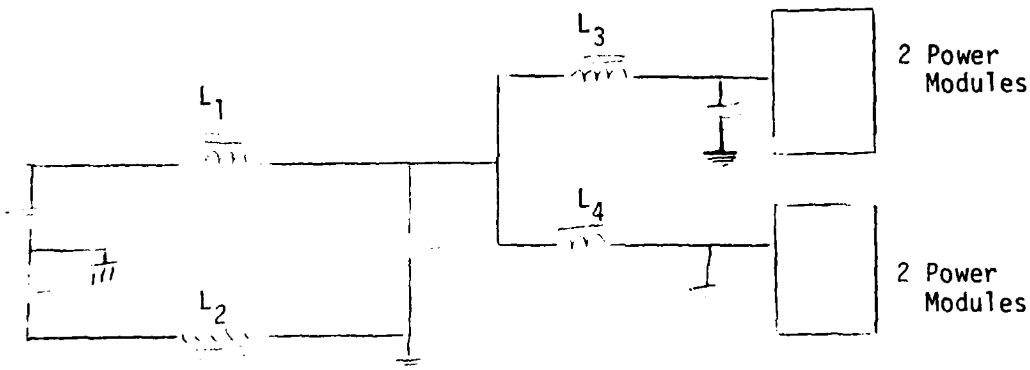
2.4 Circuit Modifications Since the Original Development Model.

- Improved input filter configurations.
- Deletion of optical isolation.
- Modified remote sensing circuit.
- Added energy recovery networks to the power stages.
- Modification to the undervoltage protection circuit.

2.4 Circuit Modifications since the Original Development Model. (Cont'd)

Input Filter

The input filter configuration is as shown:



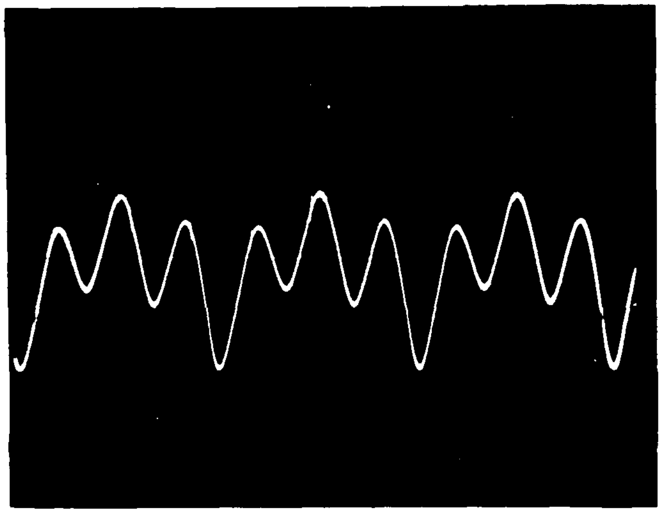
The advantages of this configuration are, it reduces the circulating currents between the two halfs of the power modules via L3, L4 and L1, L2, and it provides common mode filtering capability.

The expected (Based upon computer analysis) performance of this two stage filter is 1mA pk reflected into the power source by the power processor as shown below:

Input: Large signal due to Power source ripple.

I = 2A/cm

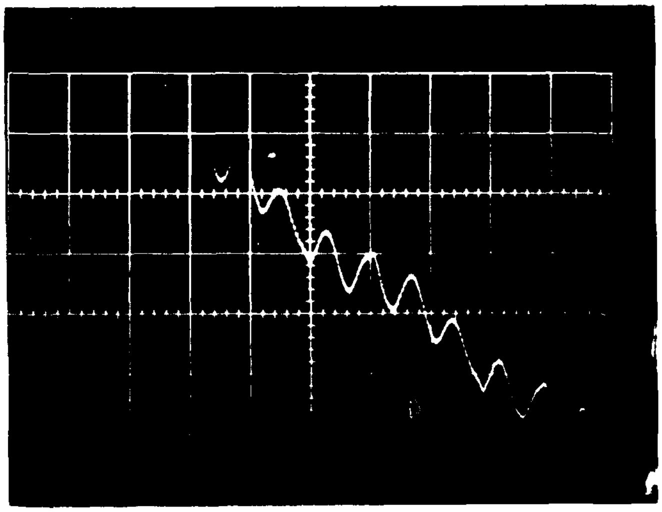
t = 5msec/cm



The above blown up.

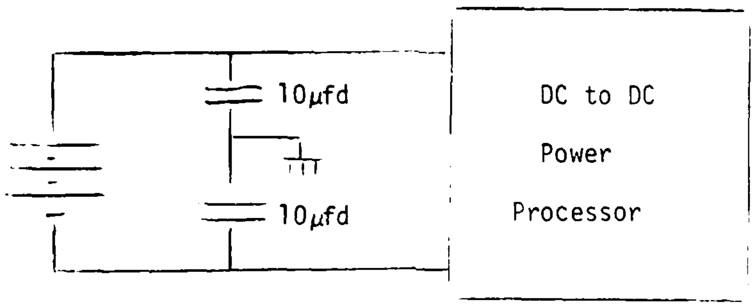
T = 50mA/cm

t = 20μsec./cm



The MIL-STD-462 (EMI) test set-up degrades the input filter capability as shown below.

This photo was taken using a battery as a source and <u>without</u> the 10μfd capacitors connected.

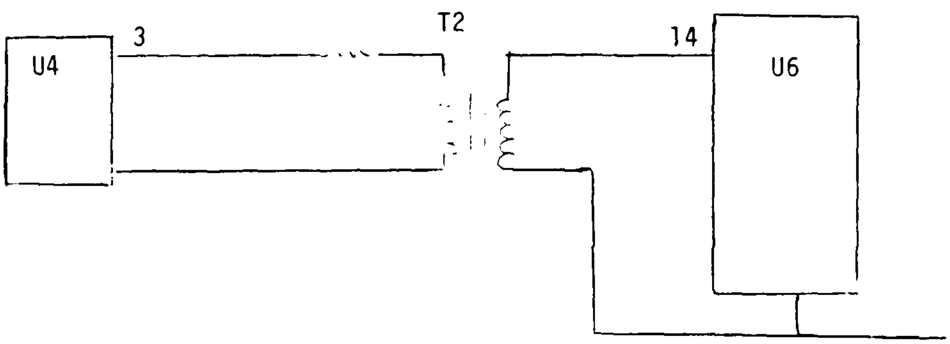


I = 25mA/cm

t = 20μsec/cm

DELETION OF OPTICAL ISOLATOR

Due to noise consideration relative to the optical isolator previously used to provide isolation for the control electronics and the output return, the optical isolator has been removed. In its place, a small pulse transformer has been inserted to the circuit configuration, as is shown below:

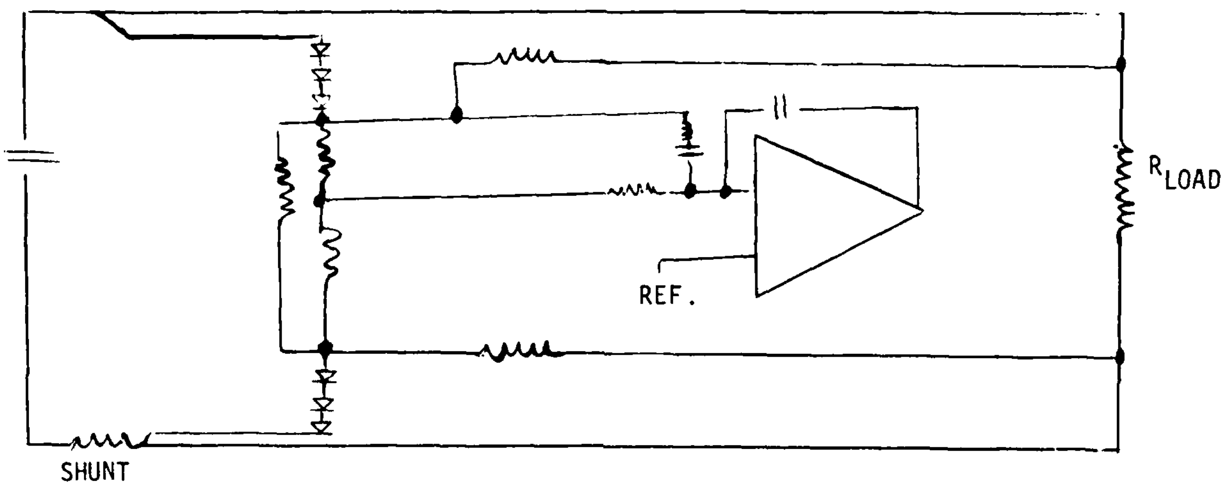


The advantage of this circuit over the one used previously is better noise immunity in this critical location of the control electronics while providing the necessary input to output isolation.

REMOTE SENSING

This circuit was modified to provide more protection in the event something would happen to the remote sense leads other than an open circuit.

The circuit is as shown:



The advantages of this circuit are:

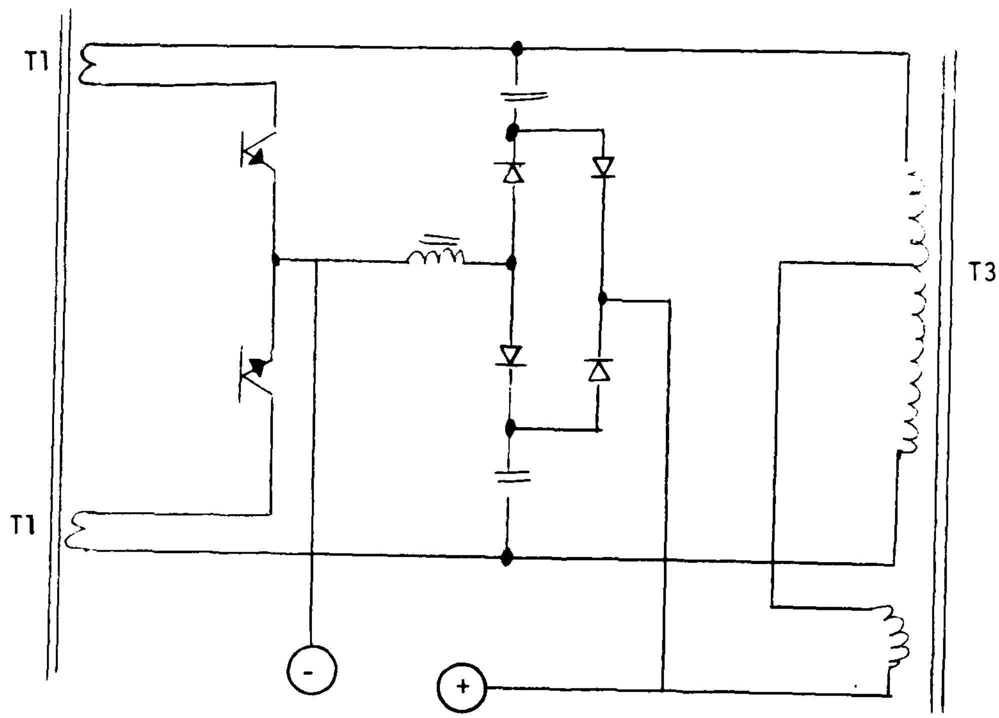
The sense leads can be opened or shorted (either to ground or together) or they can be reversed without losing control of the DC to DC Power Processor.

ENERGY RECOVERY CIRCUIT

These circuits were added primarily to reduce the voltage stresses on the power transistors. These transistors are more delicate than the originals, although they switch faster and have lower saturation voltages.

These circuits return part of the switched energy back to the power source as well as reduce the transistor collector to emitter voltage stress.

The circuit is as follows:



3.0 Summary of Requirements Vs Capabilities

Section 3.1 Requirement (Performance)	TEST RESULTS
3.1.1 **Duty Cycle.** . . . . . The equipment shall be capable of meeting all the requirement of 3.4 on a continuous duty basis.	All test results are continuous duty.
3.1.2 Output Voltage. a) The voltage across the output of the power processor shall be 28.0 volts $\pm 1\%$ over the load range of 0-75 Amperes. b) The output voltage shall also be adjustable over the range of 24.0 to 32.0 volts by an external locking type control and shall be $\pm 1\%$ of the voltage setting over the load range of from 0-75 Amperes.	a) Regulation is within 0.1% over 0 to 75 Amperes load range. b) (Adjust Range) $21.3V \leq V_{out} \leq 32.4V$ At V_{out} = 24V Regulation is within 0.10% At V_{out} = 32V Regulation is within 0.10%
3.1.3 Ripple. a) The Rms ripple shall not exceed 0.5% at any load from 0 load to full load. b) The peak to peak ripple voltage including switching spikes and other noise components shall not exceed $\pm 1\%$ at any output condition from 0 load to full load. $20\ Hz \leq f < 40MHz$	a) $<0.1\%$ b) The peak to peak ripple $\leq \pm 0.63\%$ $20Hz \leq f \leq 10MHz$ (Worst Case)

3.0 Summary of Requirements Vs Capabilities

Section 3.1 Requirement (Performance)	TEST RESULTS
3.1.4 Recovery Time. a) The output voltage of the Power Processor shall recover to 28.0 volts +1% within 25 milliseconds when the load is switched from no load to full load and from full load to no load. b) The maximum instantaneous overshoot voltage under these conditions, and for any turn-on or turn-off condition of the Power Processor shall not exceed 10% on the nominal voltage (28.0V)	a) $T_{recovery} < 15$msec. No load to full load. * $T_{recovery} > 25$msec. Full load to no load. b) $\overline{V}_{instantaneous} = 2.5\%$
3.1.5 Stability. Output voltage drift at a constant load and ambient temperature shall not exceed 0.5% over a period of 24 hours.	Output voltage drift < 0.07%
3.1.6 Temperature Coefficient. Change in output voltage as a function of ambient temperature shall not exceed 0.02 percent per degree F over the specified operating temperature range.	The change in voltage is .00073%/°F $-26°F \leq T \leq 145°F$

* A BLEEDER RESISTOR (WITH AN ATTENDANT LOSS OF EFFICIENCY) IS REQUIRED TO MEET THIS REQUIREMENT.

3.0 Summary of Requirements Vs Capabilities

Section 3.1 Requirement (Performance)	TEST RESULTS
3.1.7 Current Limiting. a) Automatic control circuitry shall limit the output current to a maximum value of 75 Amperes +5%, -0%, to protect the power processor from overload and automatically restore the output when the overload is removed. b) The current limiting shall be manually adjustable by means of a front panel control over the range of 5 to 75 Amperes.	a) Current regulation is $\pm 1\%$ due to input voltage change at any setting of output current. b) Adjust Range $2.4A \leq I_{out} \leq 75.6A$
3.1.8 Efficiency. The overall efficiency of the power processor shall not be less than 85% at full load, nominal input voltage.	$\eta =$ 87.4% AT 28Vinput, 75A Load AT +75°F. $\eta =$ 86.1% AT 28Vinput, 75A Load AT +145°F $\eta =$ 88.3% AT 28Vinput, 75A Load AT -26°F

3.2 Reliability Prediction

A reliability prediction was performed early in the contract CLIN, Item C001. This prediction is revised here to include the part changes (quantity, type, stress). Both prediction are based upon MIL-HBK-217B. **Table** 1, presents the part types, failure rate, quantity of components used and total failure rate.

The analysis shows a 13,868 hour meantime between failure, and this exceeds the 2,000 **MTBF** contract goal.

Revised Reliability Prediction

	Failure Rate Per 10^9 Hours
Front Panel	3546
Back Panel	11024
Chassis	9554
Side Panels	34304
Control Electronics	13677

$$\Sigma\tau_\rho = 72105 \times 10^{-9}$$

MBTF = $^1/_{\tau_\rho}$ = 13,868 hours

Exceeds 2,000 Hr. Design Goal.

FRONT PANEL

Part Type	Failure Rate Per 10^9 Hour	Quantity	Total Failure Rate Per 10^9 Hour.
Switch, Toggle	1497	11	1497
Resistor, Variable	90	2	180
Resistor, Film	9	1	9
Meter	500	1	500
Connector(9)	80	2	160
Fuse Holder	100	2	200
Circuit Breaker	500	2	1000
		TOTAL:	3546

BACK PANEL

Inductors (Power)	503	4	2012
Connectors (Power)	4506	2	9012
		TOTAL:	11024

CHASSIS

Capacitors, Alum.	630	15	9450
Shunt	10	1	10
Transformer, Pulse	94	1	94
		TOTAL:	9554

TABLE 1

POWER MODULE

PART TYPE	Failure Rate Per 10^9 Hour	Quantity	Total Failure Rate Per 10^9 Hour
Inductor, Power	503	2	1006
Connector	80	1	80
Transistor, Power	1100	2	2200
Diode, Power	75	3	225
Capacitor, Alum	630	6	3780
Capacitor, Polycarb	34	1	34
Transformer, Pulse	94	2	188
Capacitor, Ceramic	13	4	52
Diode, Med. Power	75	5	375
Inductor, Pulse	94	1	94
Transformer, Power	503	1	503
Resistor, Carbon	7.7	5	39
			8576

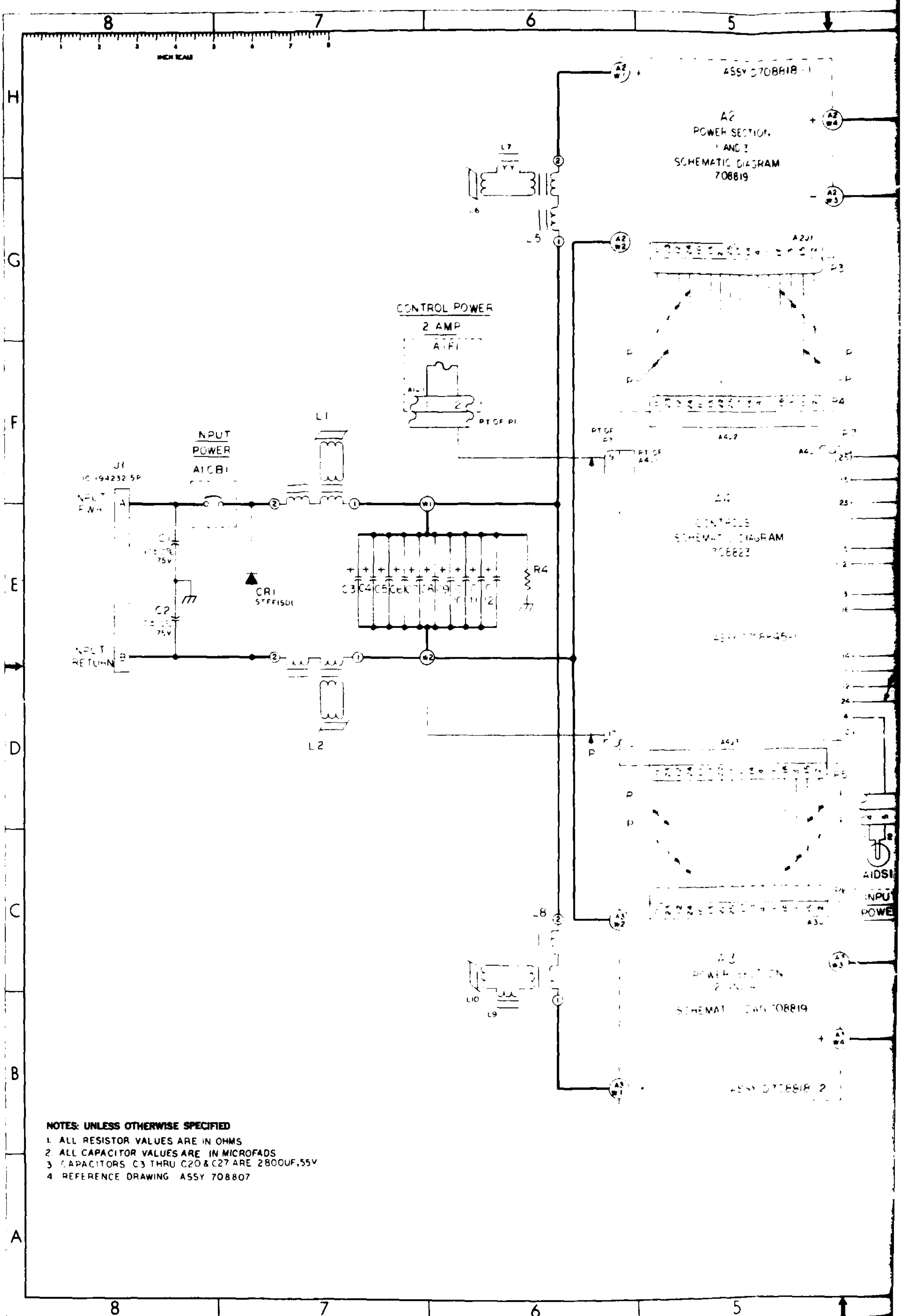
Total for 4 Modules = 34304

CONTROL ELECTRONICS

Capacitor, Tant. Foil	17	16	272
Capacitor, Ceramic	13	43	559
Capacitor, Glass	7.5	12	90
Resistors, Film	9	80	720
Resistors, Wirewound	26	17	442
Resistors, Carbon	7.7	42	323
Diode, General Purpose	75	10	750
Diode, Med. Power	75	23	1725
Diode, Zener	910	2	1820
Transistor, Low Power	110	17	1870
Transistor, Power	1100	1	1100
IC, Voltage Comparator	186	6	1116
IC, Op-Amp	186	2	372
IC, Timer	193	5	965
IC, CMOS	133	1	133
IC, Regulator	175	4	700
IC, TTL	45	16	720
			13677

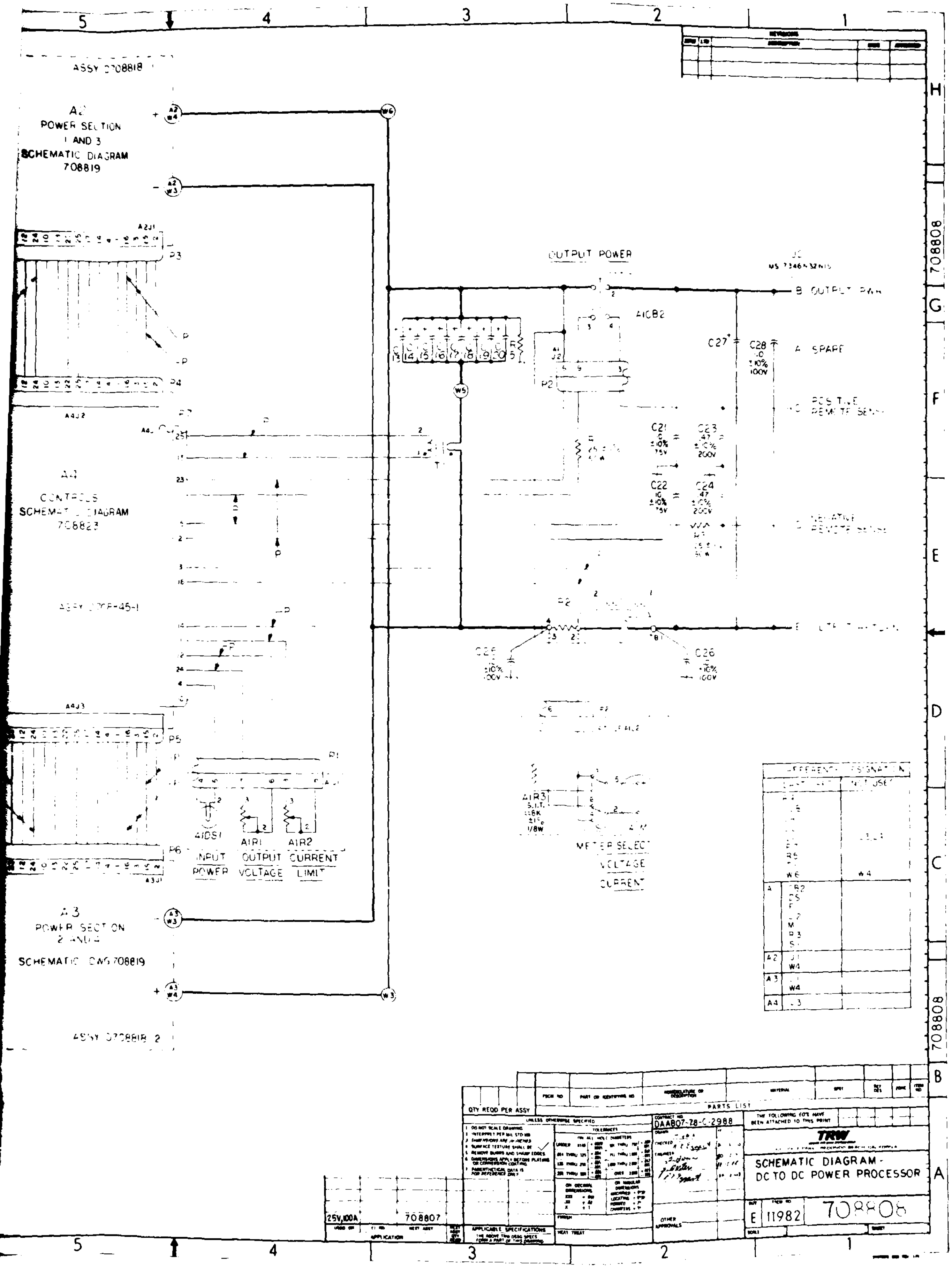
TABLE 1 (cont'd)

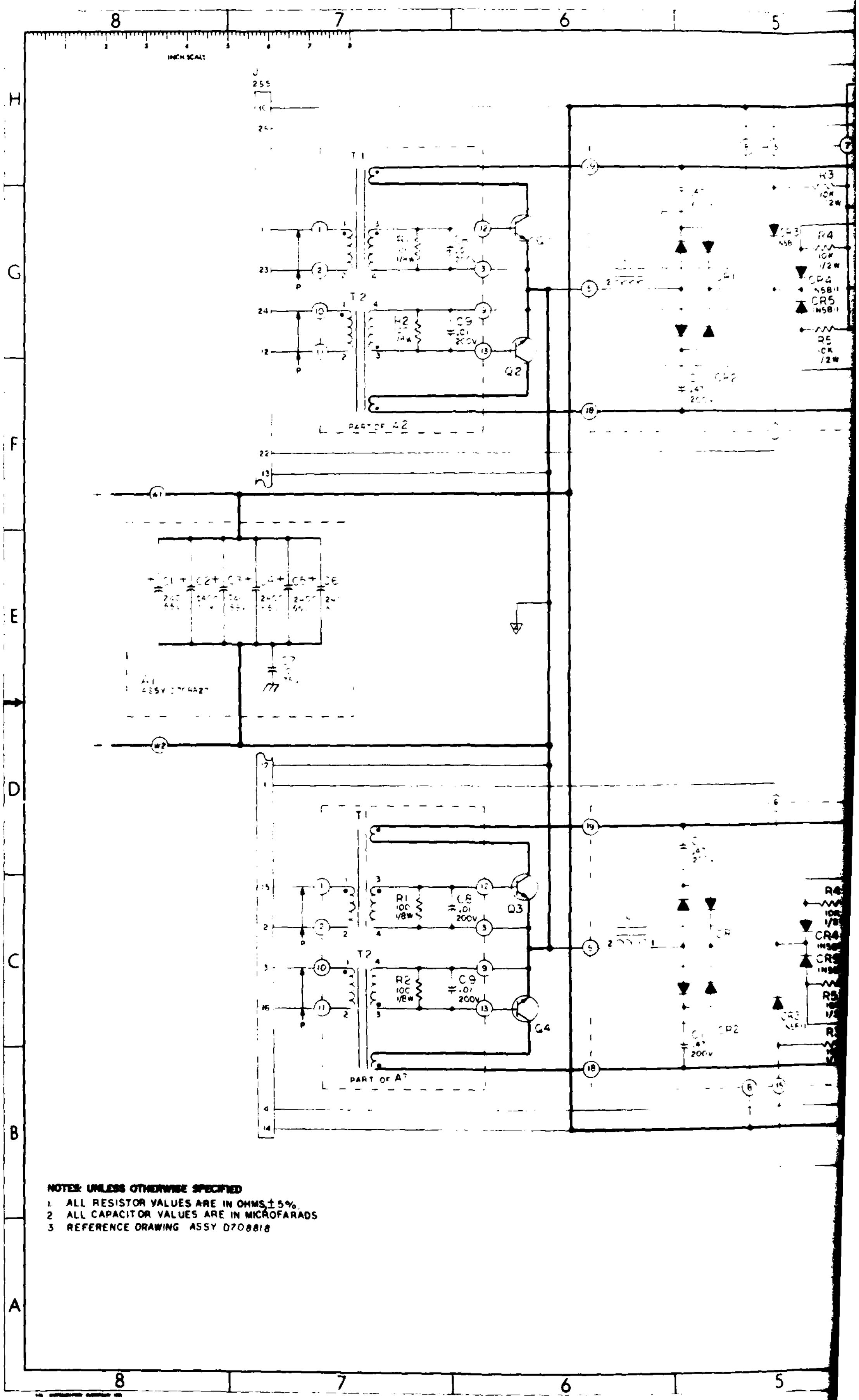
4. SCHEMATIC DIAGRAMS



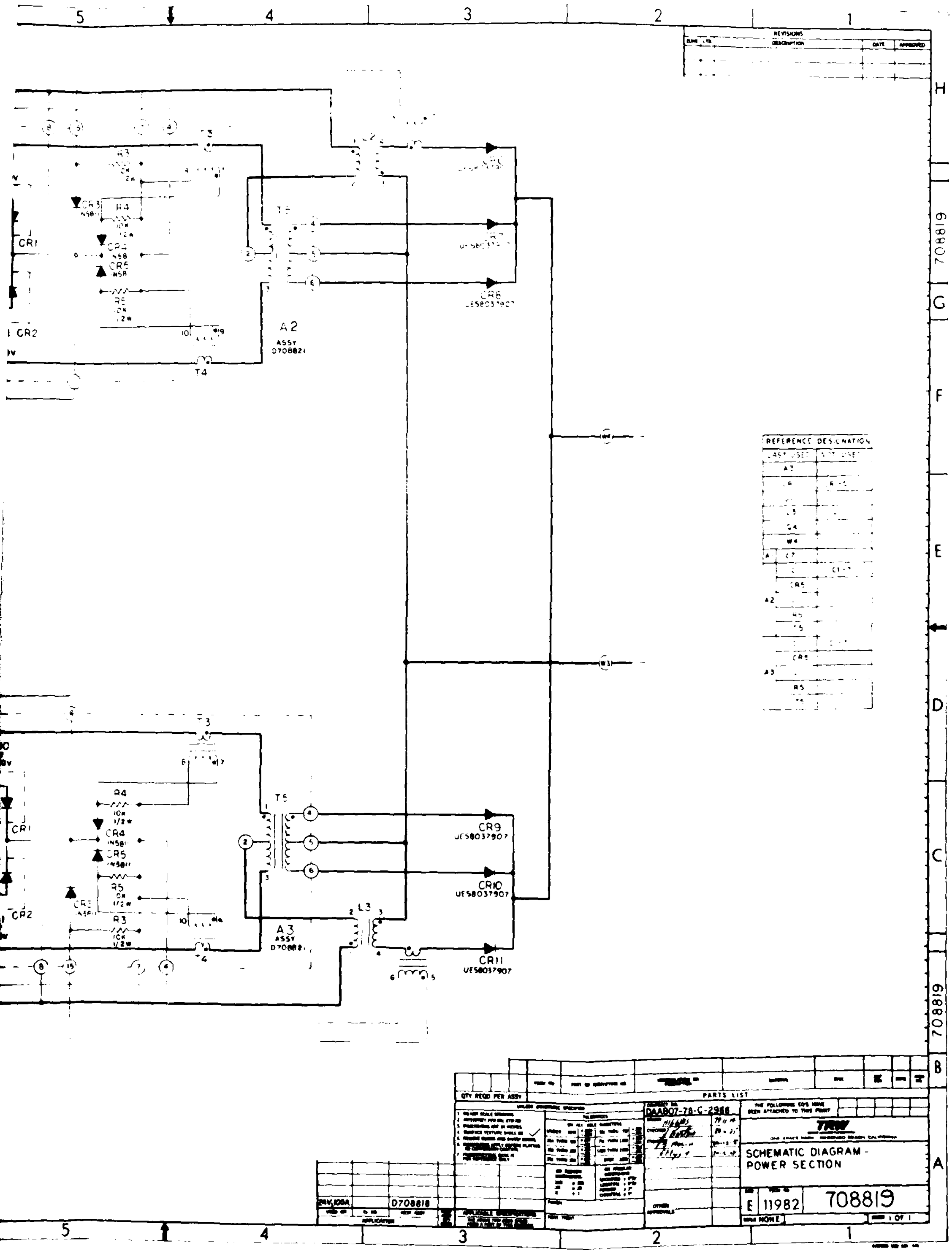
NOTES: UNLESS OTHERWISE SPECIFIED

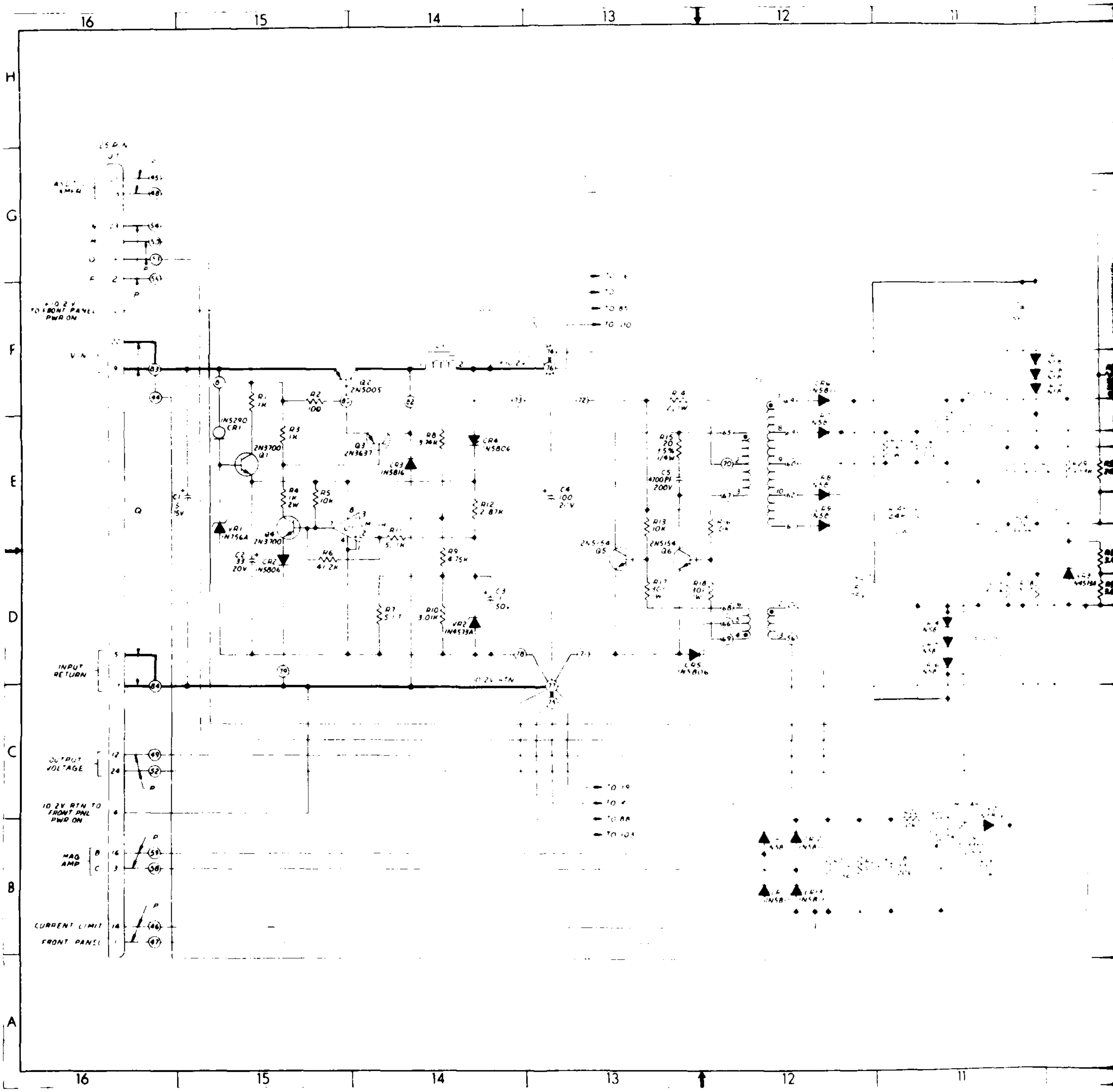
1. ALL RESISTOR VALUES ARE IN OHMS
2. ALL CAPACITOR VALUES ARE IN MICROFADS
3. CAPACITORS C3 THRU C20 & C27 ARE 2800UF,55V
4. REFERENCE DRAWING ASSY 708807


ASSY 708818
A2
POWER SECTION
1 AND 3
SCHEMATIC DIAGRAM
708819
OUTPUT POWER
A1CB2
B OUTPUT PWR
A SPARE
C27
C28
C25
C26
C21
C22
C23
C24
A4
CONTROLS
SCHEMATIC DIAGRAM
708823
A1DS1
INPUT
POWER
A1R1
OUTPUT
VOLTAGE
A1R2
CURRENT
LIMIT
A1R3
METER SELECT
VOLTAGE
CURRENT
A3
POWER SECTION
2 AND 4
SCHEMATIC DWG 708819
ASSY 708818-2
PARTS LIST
QTY REQD PER ASSY
DAAB07-78-C-2988
TRW
SCHEMATIC DIAGRAM -
DC TO DC POWER PROCESSOR
E
11982
708808
25V,100A
708807
APPLICATION
APPLICABLE SPECIFICATIONS
708808

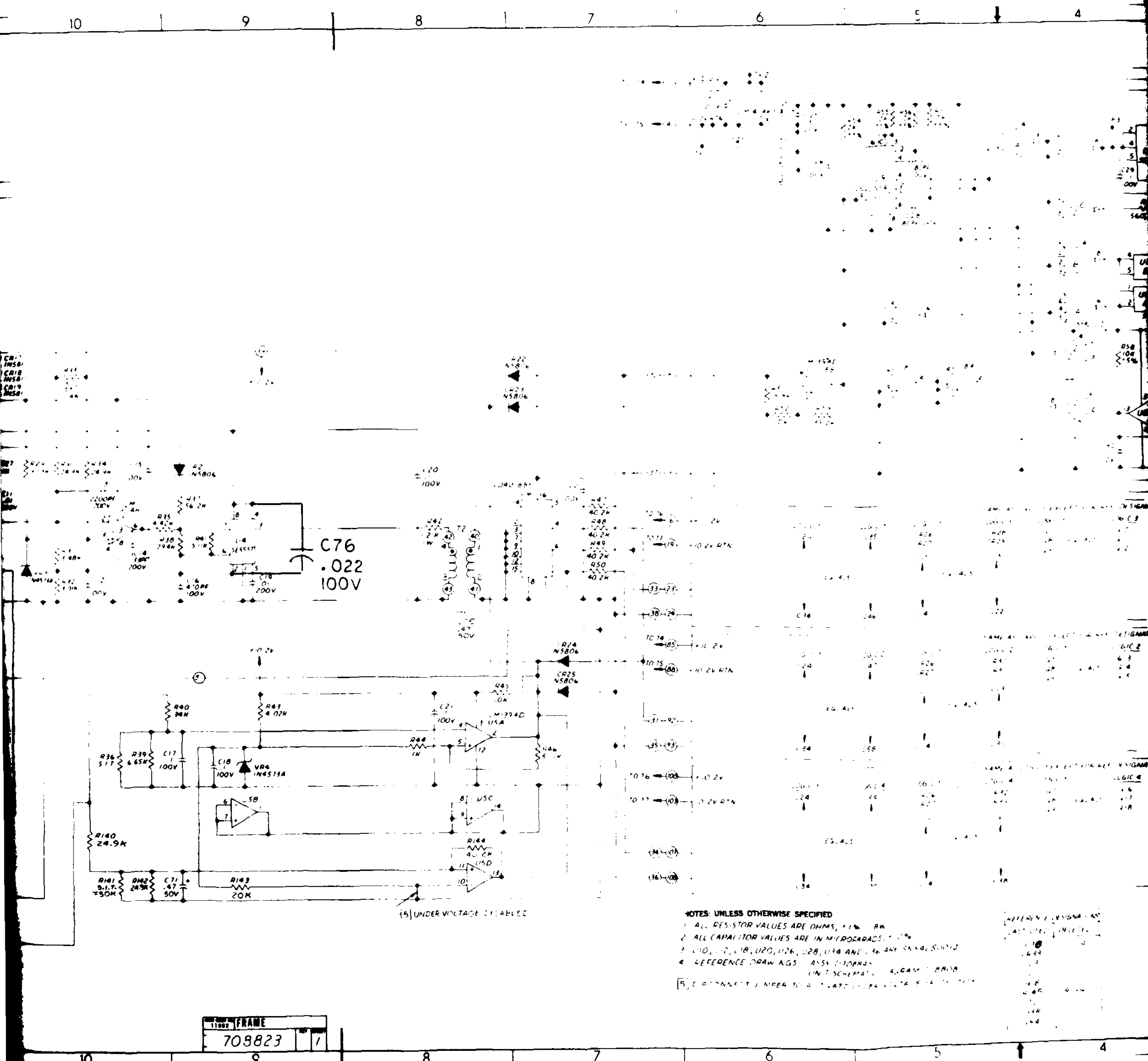


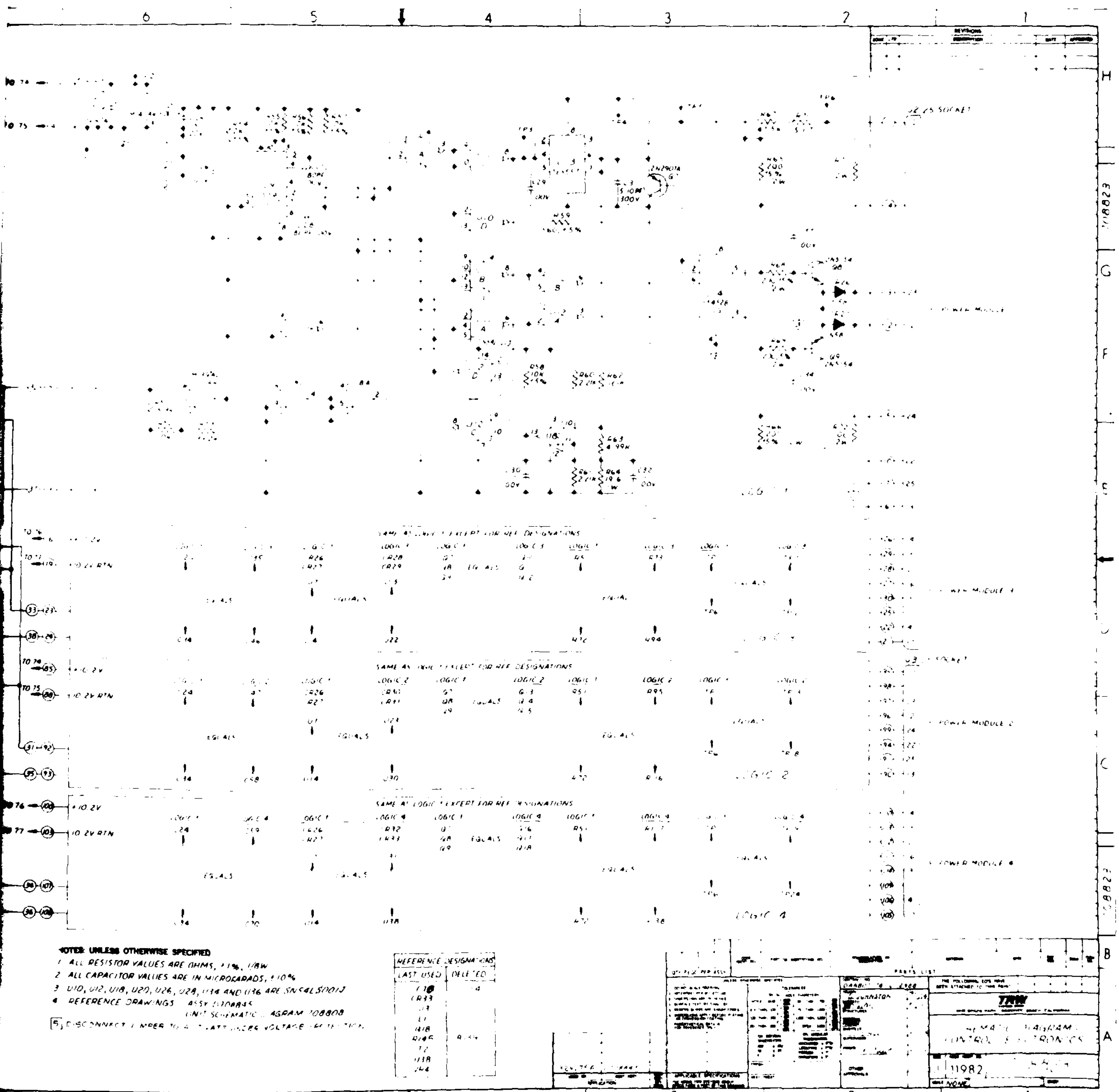
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS ± 5%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS
3. REFERENCE DRAWING ASSY D708818


CR1
CR2
R3
R4
CR3
CR4
CR5
R5
T3
T4
T5
L2
A2
ASSY
D708821
CR7
CR8
UE58037907
CR9
UE58037907
CR10
UE58037907
CR11
UE58037907
L3
A3
ASSY
D708821
W3
REVISIONS
REFERENCE DESIGNATION
PARTS LIST
QTY REQD PER ASSY
DAAB07-78-C-2966
TRW
SCHEMATIC DIAGRAM -
POWER SECTION
E
11982
708819
SCALE NONE
SHEET 1 OF 1
24V,100A
D708818
APPLICATION
708819
708819



16
15
14
13
12
11
H
G
F
E
D
C
B
A
INPUT RETURN
OUTPUT VOLTAGE
10.2V RTN TO FRONT PNL PWR ON
MAG AMP
CURRENT LIMIT
FRONT PANEL
2N5005
2N3700
2N3637
IN5290
IN756A
IN5816
IN5806
IN4573A
2N5154


C76
.022
100V
R40
R41
R36
R39
C17
C18
VR4
R44
R46
R140
24.9K
R141
R142
C71
R143
20K
R144
U5A
U5B
U5C
U5D
CR24
CR25
[5] UNDER VOLTAGE DISABLED
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE OHMS
2. ALL CAPACITOR VALUES ARE IN MICROFARADS
4. REFERENCE DRAWINGS
FRAME
708823


SAME AS LOGIC 1 EXCEPT FOR REF DESIGNATIONS
LOGIC 2
LOGIC 4
POWER MODULE 2
POWER MODULE 4
NOTES: UNLESS OTHERWISE SPECIFIED
1 ALL RESISTOR VALUES ARE OHMS, ±1%, 1/8W
2 ALL CAPACITOR VALUES ARE IN MICROFARADS, ±10%
3 U10, U12, U18, U20, U26, U28, U34 AND U36 ARE SN54LS00J
4 REFERENCE DRAWINGS ASSY 108845
UNIT SCHEMATIC DIAGRAM 108808
REFERENCE DESIGNATIONS
LAST USED
DELETED
CR33
U18
U38
CONTROL ELECTRONICS
11982
NONE

5. MECHANICAL DESIGN.

Figure 4 shows the DC to DC Power Processor in the open position with its handling fixture. The mechanical subassembly consists of:

- Front Panel.
- Control Electronic Board.
- 2 Power Modules (left side).
- 2 Power Modules (right side).
- Rear Panel.

Figure 5 shows the Front Panel. Input power control is on the left, and output control is on the right.

Input control consists of:

- Input Circuit Breaker.
- Power ON Indicator Light.
- Fuse plus spare for control power.

Output control consists of:

- Output DC Circuit Breaker.
- DC Voltage/DC Current Meter.
- Meter Select Switch.
- Output Voltage Adjust Potentiometer.
- Output Current Adjust Potentiometer.

Figure 6 shows the Rear View of the Front Panel. It shows wiring of components.

The interface between the Front Panel and the side panels has a machined surface in order to increase the thermal resistance to the front panel, tc allow it to operate cooler than the remainder of the mechanical assembly.

Figure 7 shows the Control Electronic Assembly. It is mounted to the hinged top cover of the DC-DC Power Processor.

The Control Electroni Assembly contains in the control electronics DC-DC Converter, the 5V regulator, and the balance of the low level control electronics.

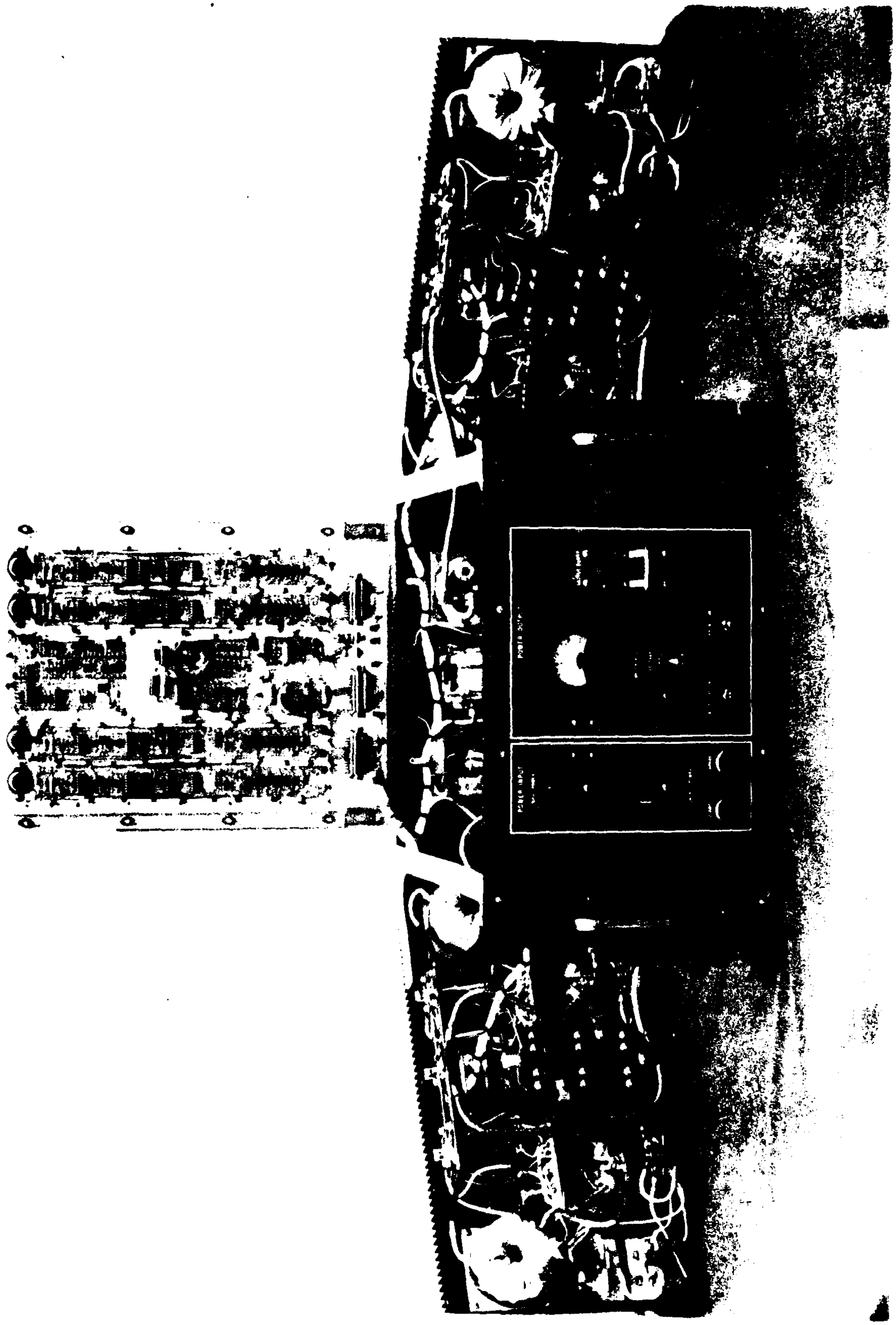
5. MECHANICAL DESIGN - (cont'd)

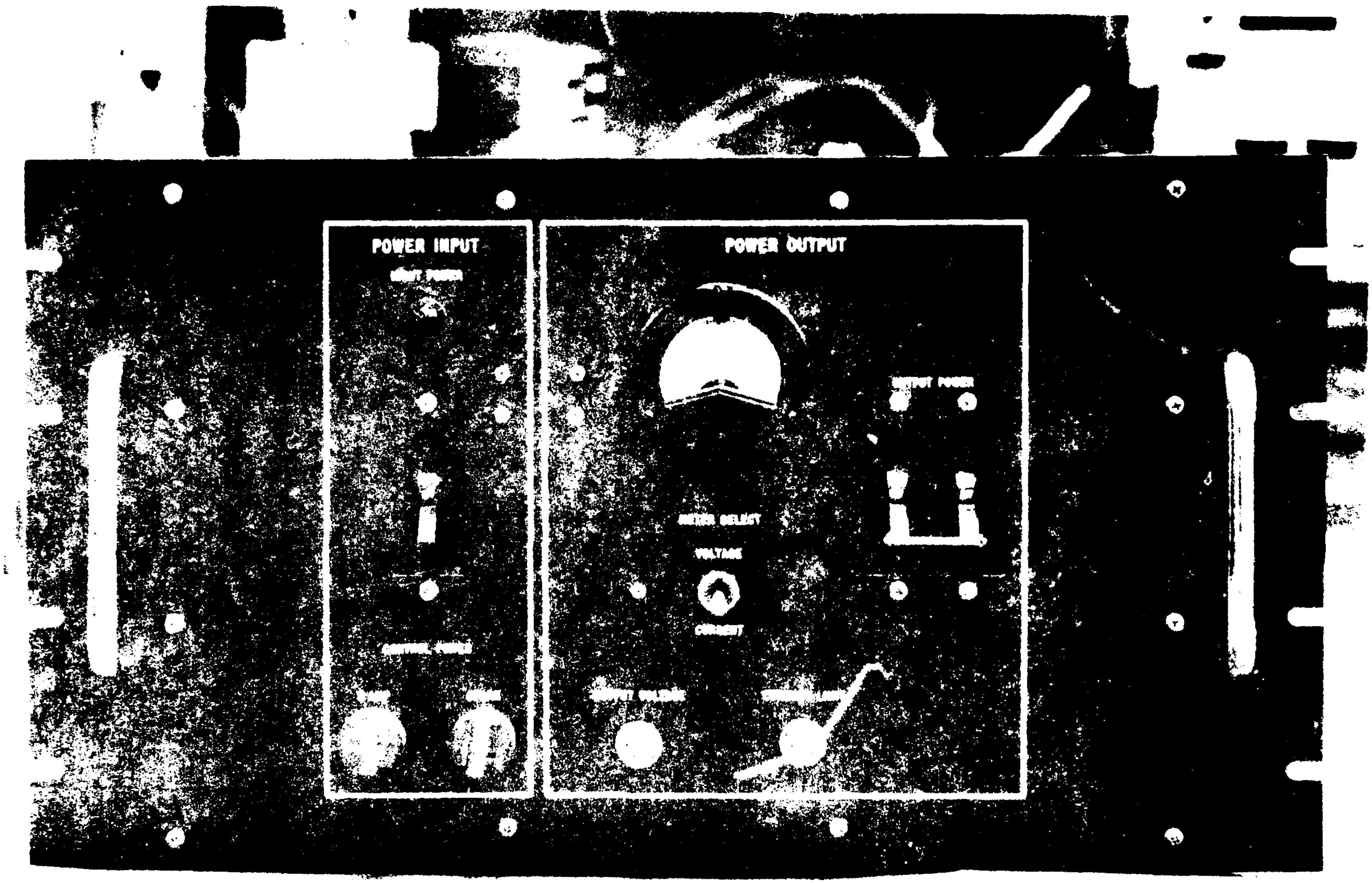
Figure 8 shows the Left Side Power Stage which contains two of the four power modules.

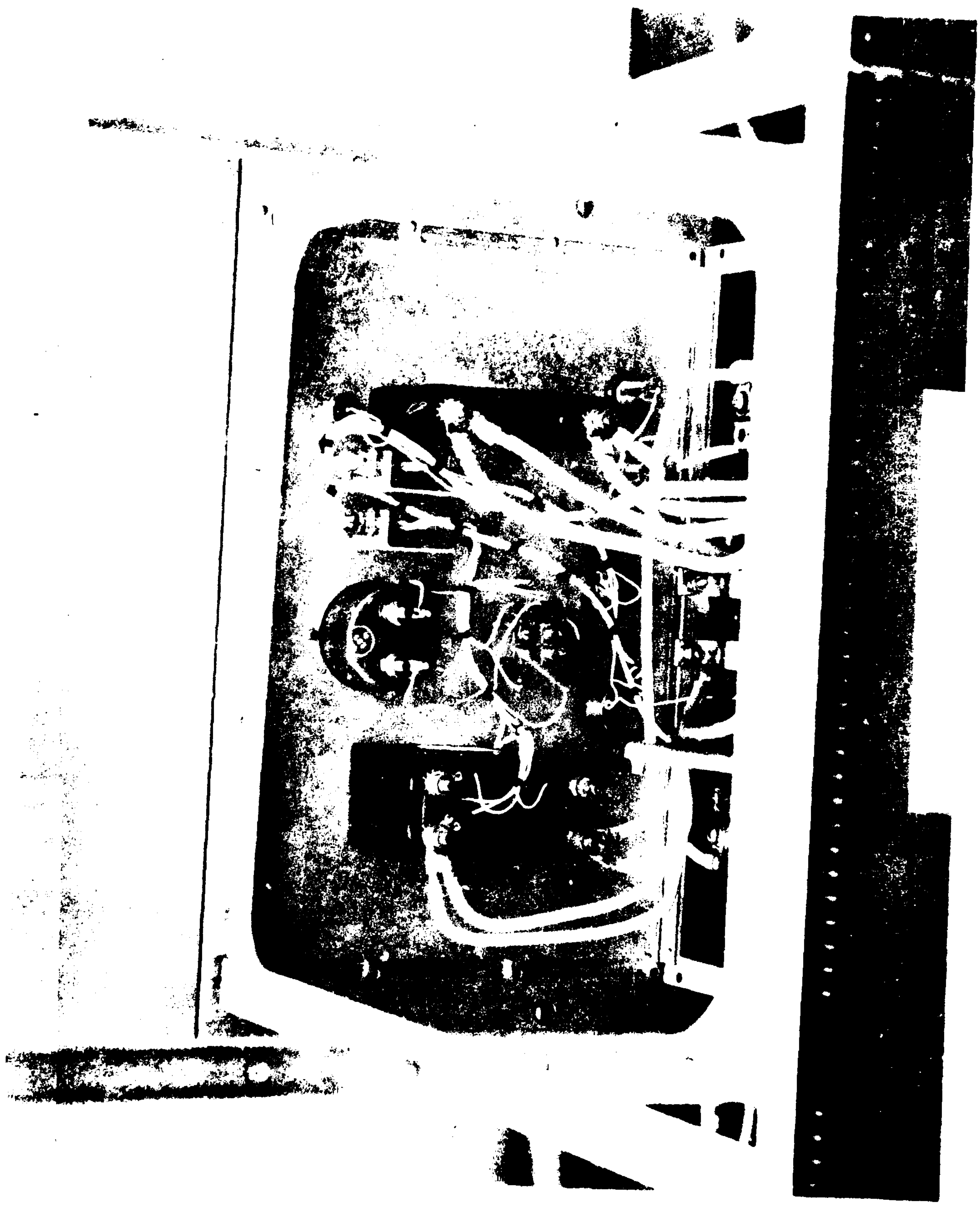
Figure 9 shows a close-up of the Back Side of the Rear Panel. In view, are the four inductors of the input filter, the connector and EMI filters.

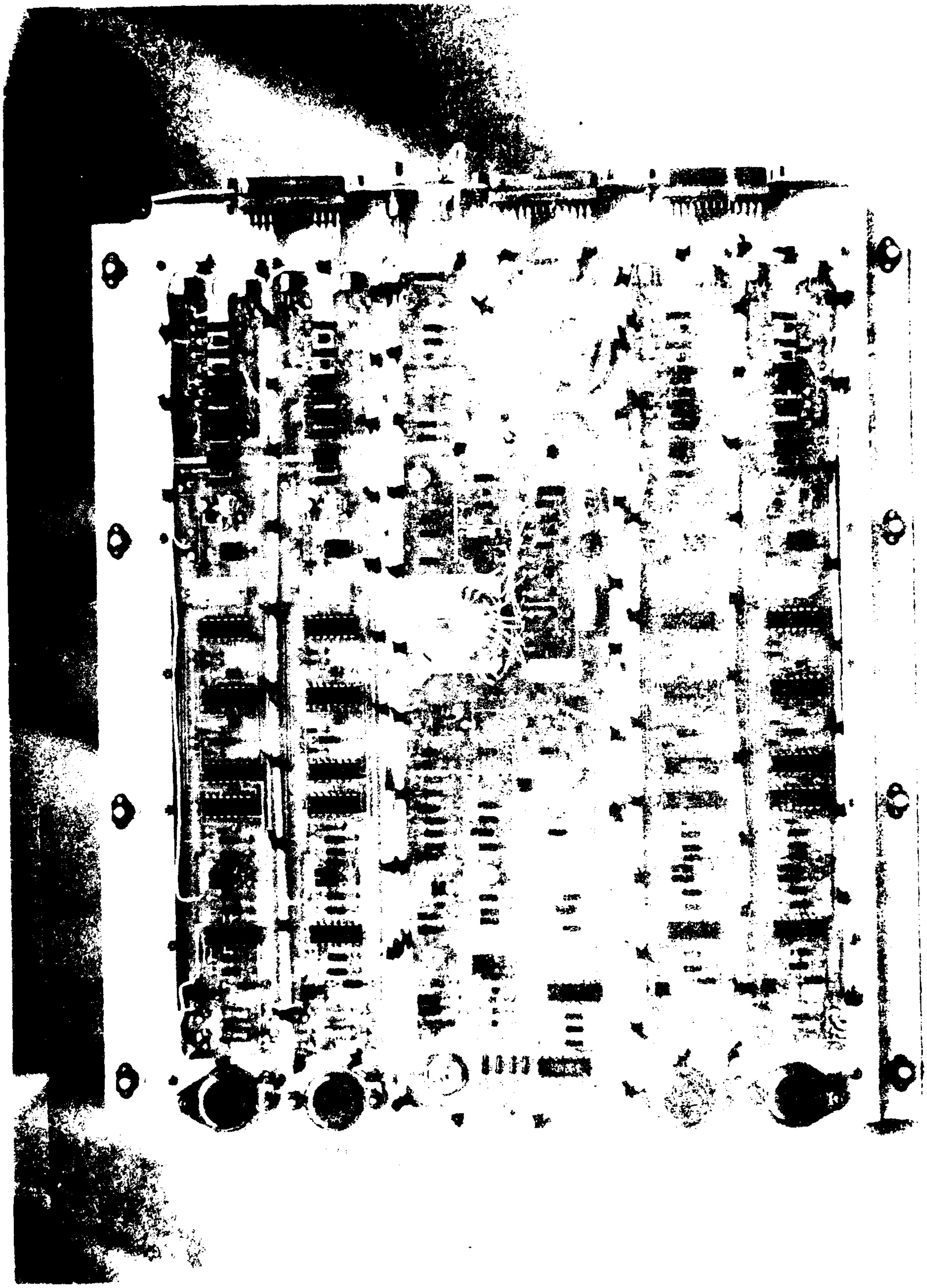
Figure 10 shows the Rear Panel with the mating connectors.

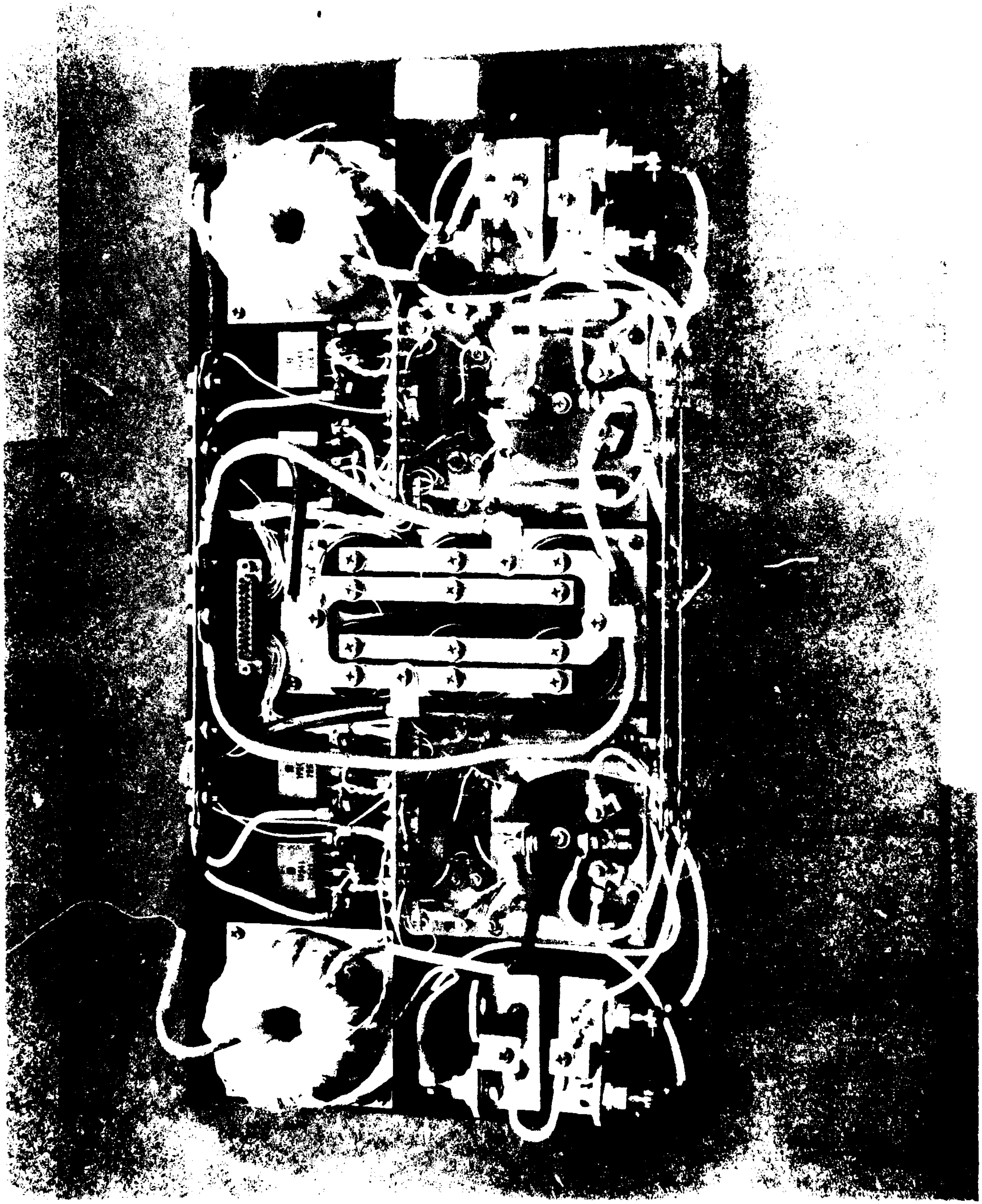
Figure 11 shows the DC to DC Power Processor completely assembled.

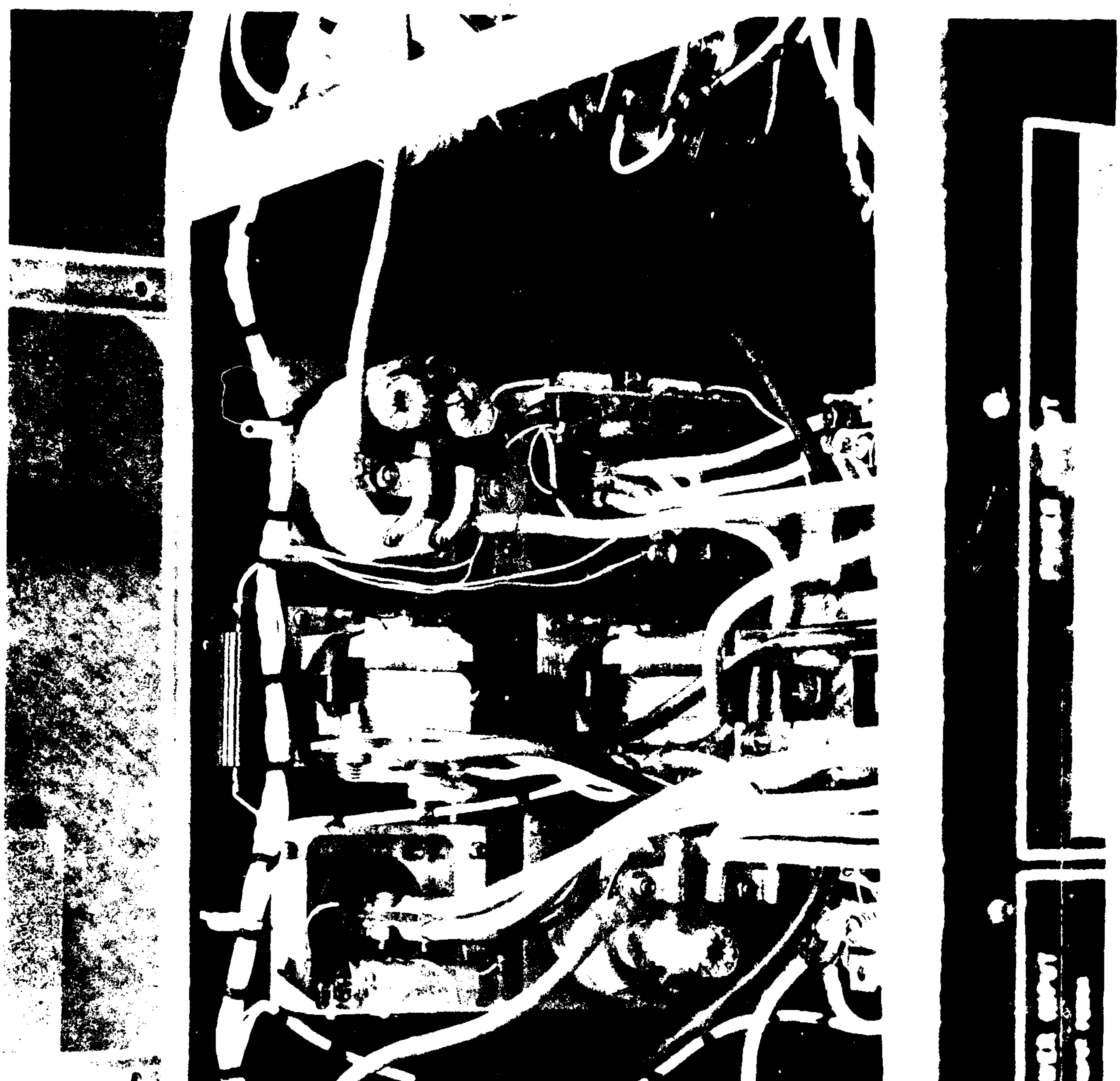


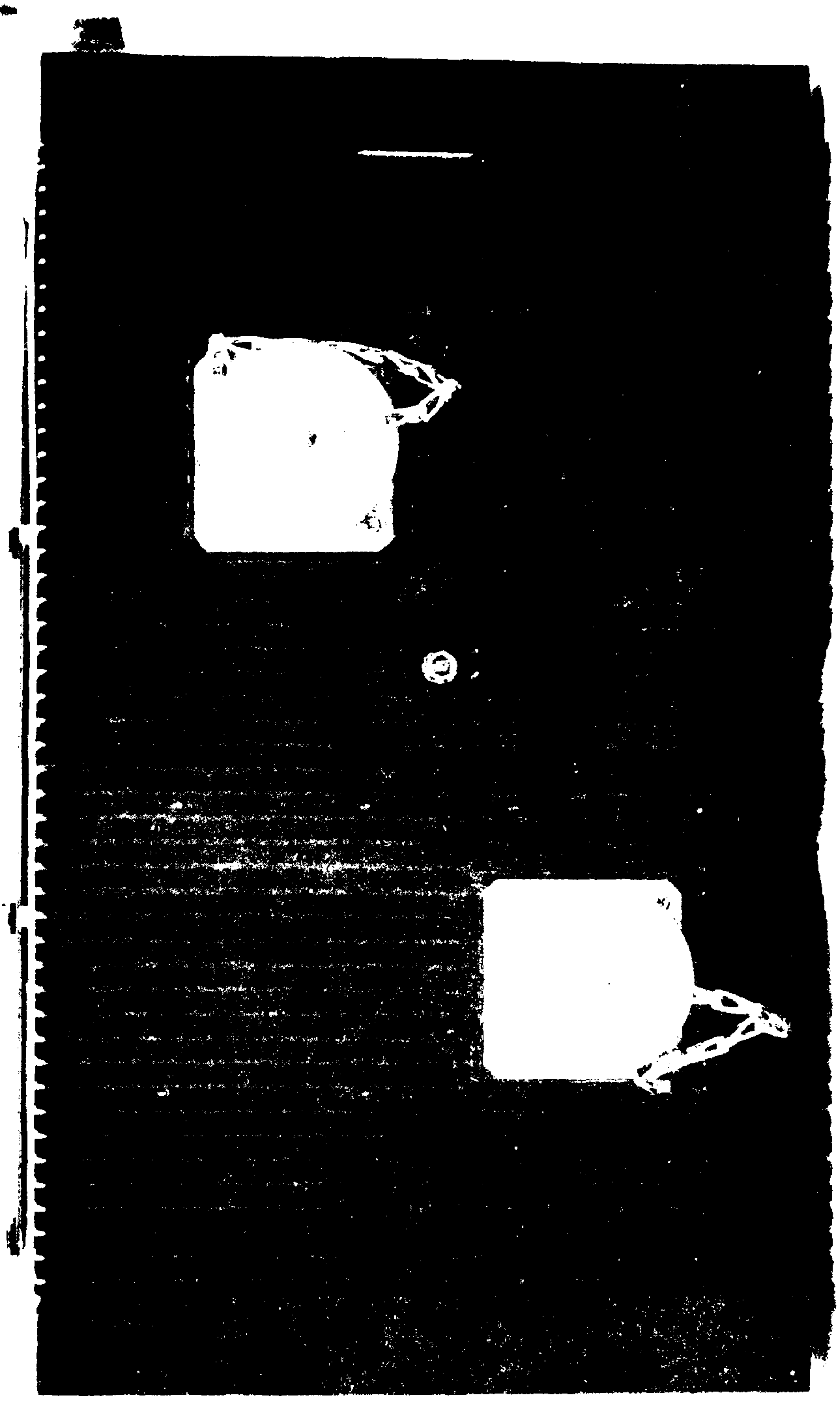

POWER INPUT
POWER OUTPUT
OUTPUT POWER
METER SELECT
VOLTAGE
CURRENT

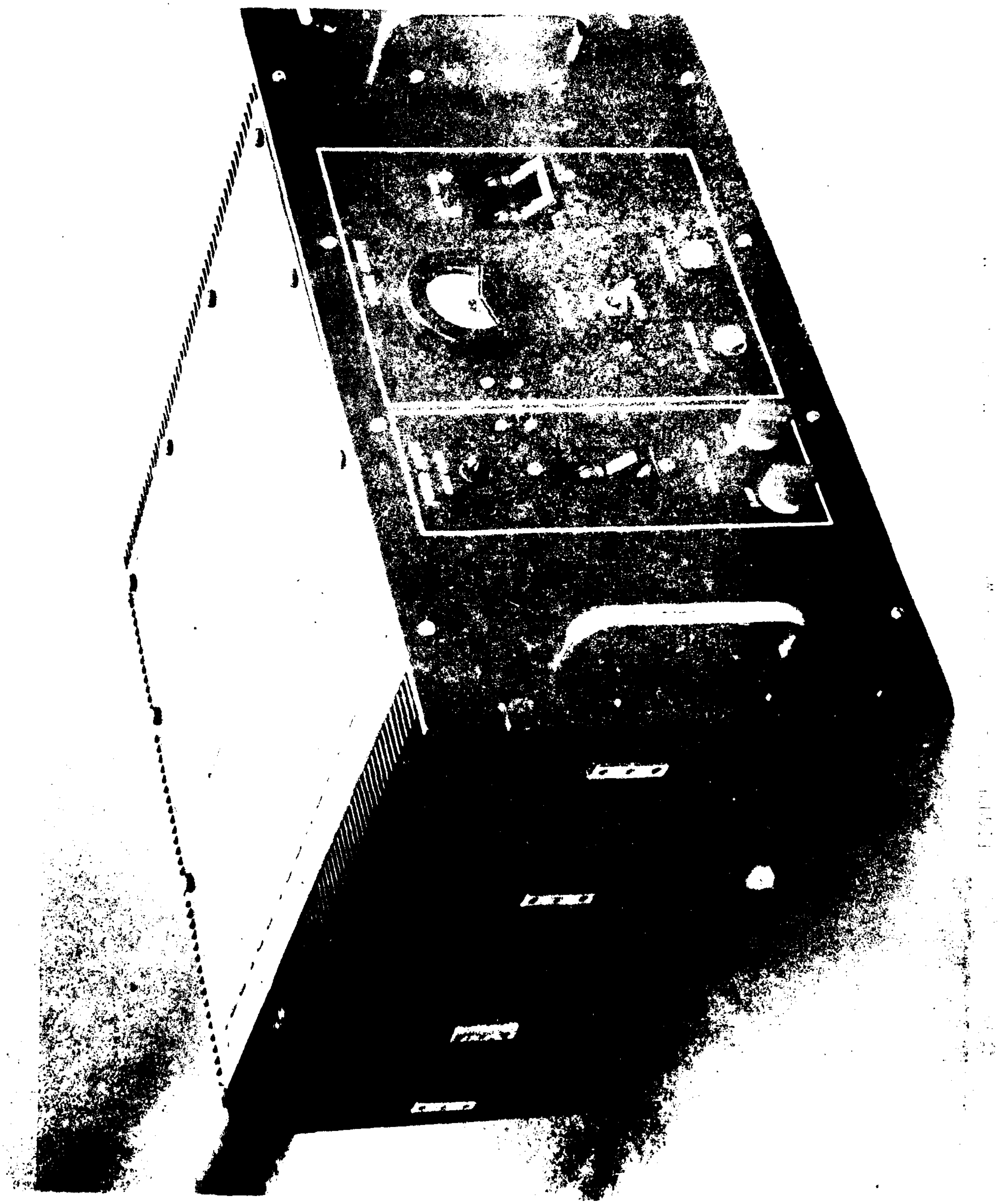












6. TEST RESULTS.

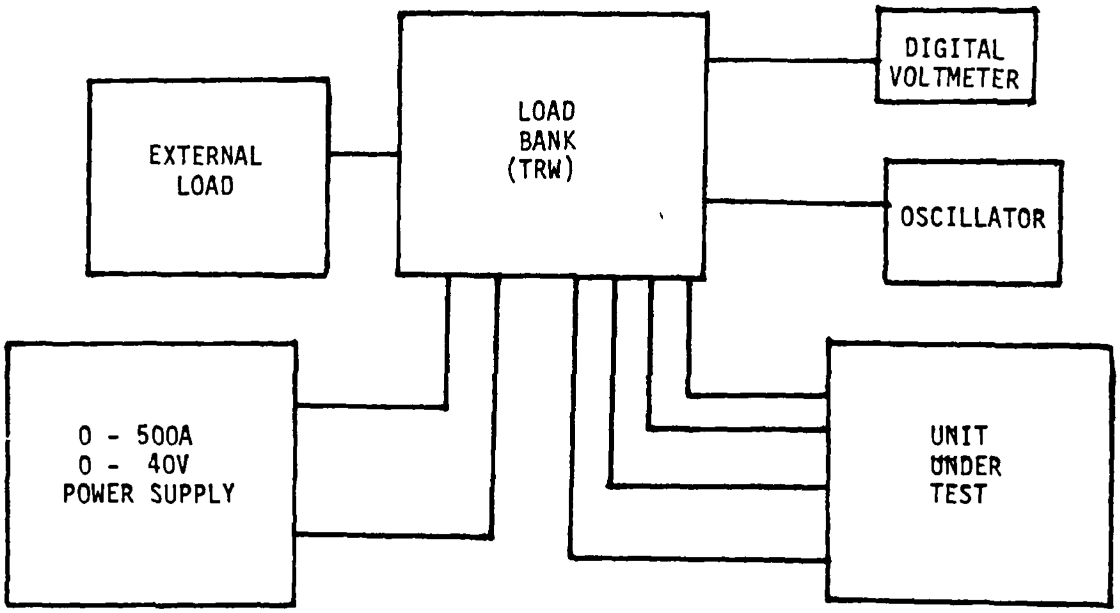
The DC-DC Power Processor models were fully tested. The following sections summarizes these test results and is grouped into the following three sub-sections:

- Electrical Performance
- Thermal Control
- Electromagnetic Interference

7. INSTRUMENTATION.

A load bank was constructed (See Figure 12 for Schematic) to be used in testing the DC to DC Power Processor.

The test set-up for a typical test is shown below.



Power Supply	- SORENSEN #DCR40-500
Digital Voltmeter	- CIMRON Model #7200A, FAIRCHILD Model #7000
Oscillator	- TEKTRONIX Model #7904, 7A26, 7B92, 7B80 Plug-in Units.

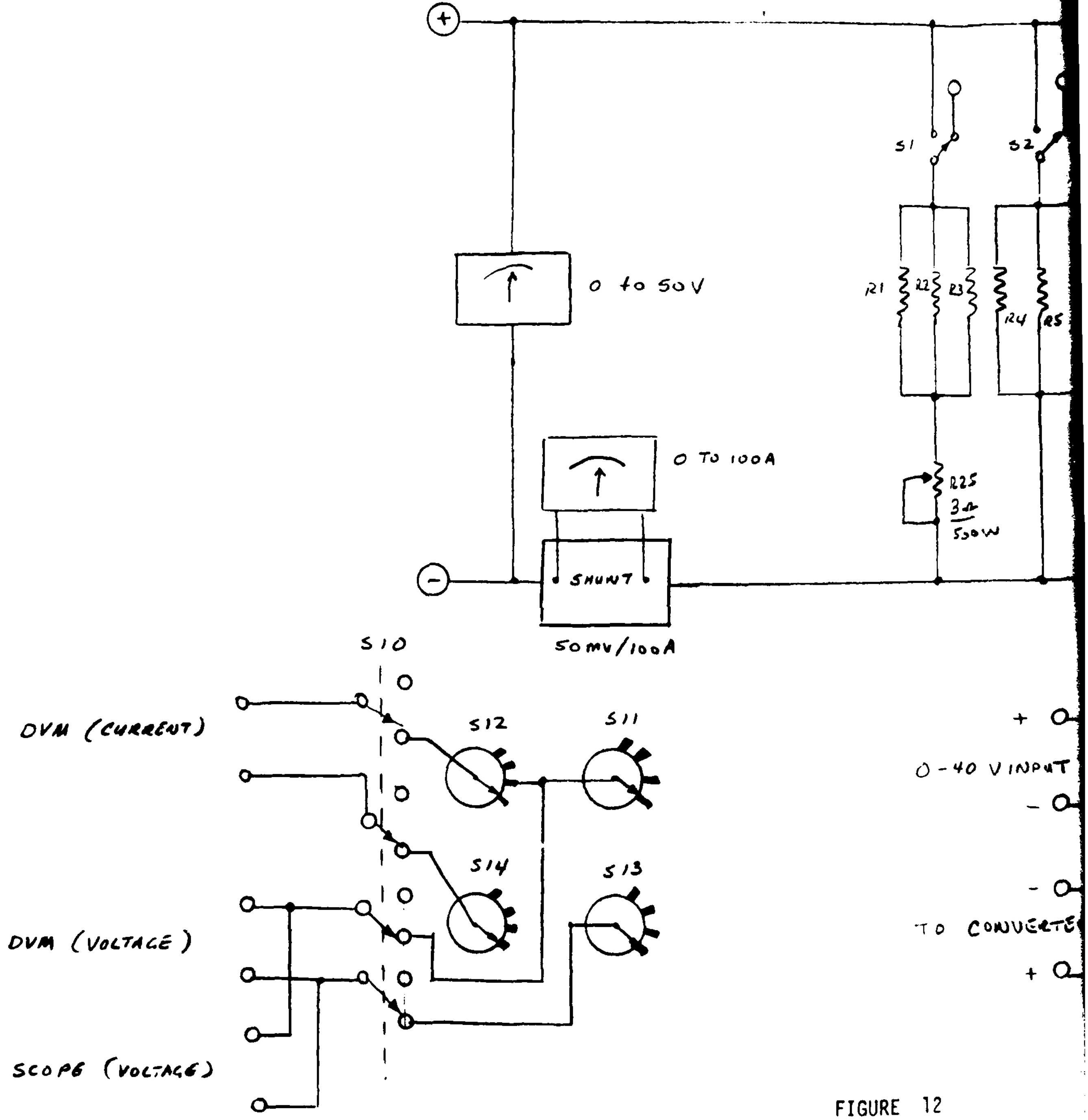
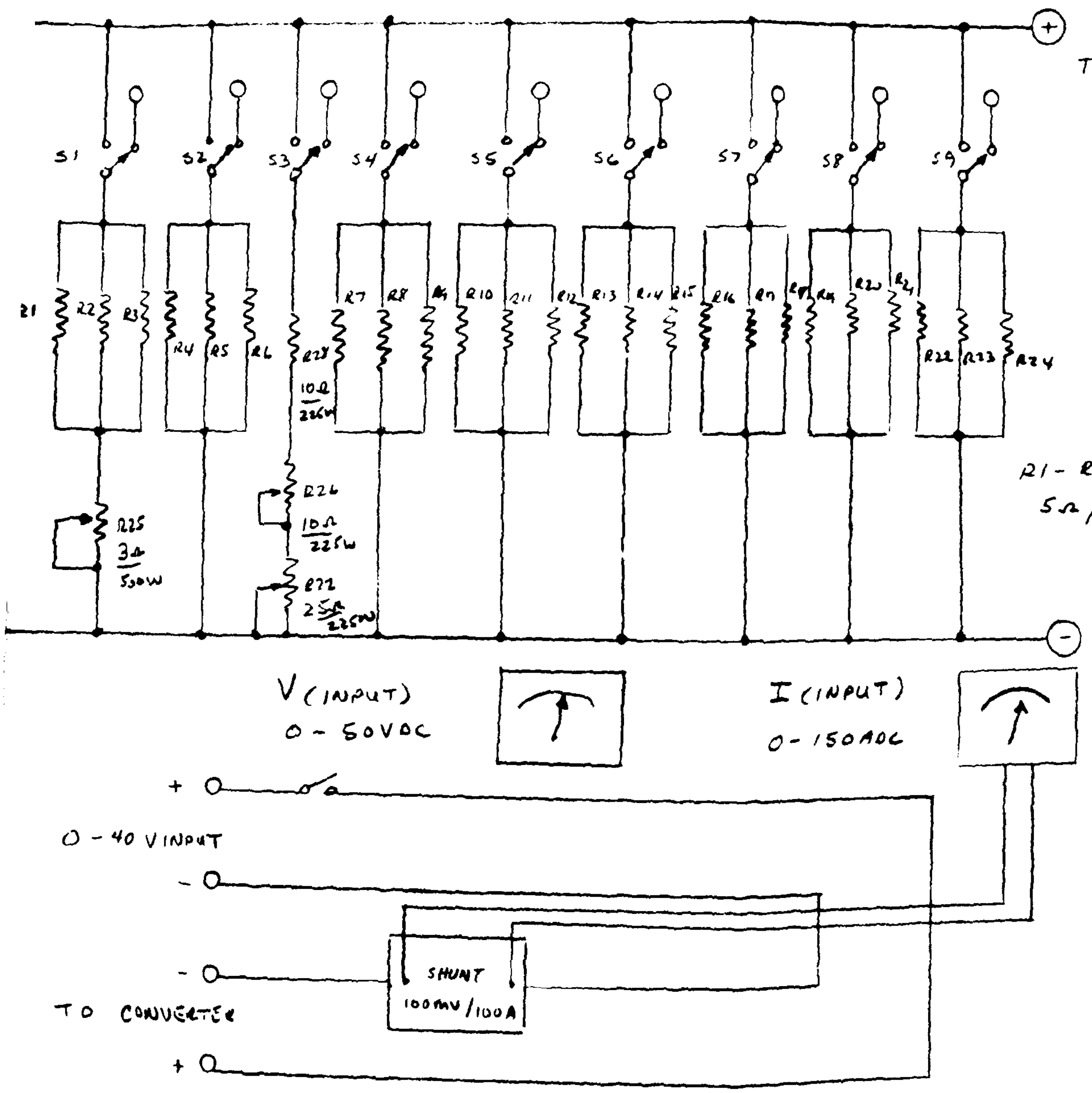

0 to 50V
0 TO 100A
SHUNT
50mv/100A
S1
S2
R1
R2
R3
R4
R5
R25
3Ω
500W
S10
S12
S11
S14
S13
DVM (CURRENT)
DVM (VOLTAGE)
SCOPE (VOLTAGE)
0-40 V INPUT
TO CONVERTE

FIGURE 12

SK	REVISIONS			
	LTR	DESCRIPTION	DATE	APPROVED



JRE 12

ENGINEERING SKETCH		TRW SYSTEMS GROUP ONE SPACE PARK • REDONDO BEACH, CALIFORNIA		
ORIGINATOR	DATE	2.4 KW DC to DC POWER PROCESSOR LOAD BANK		
		SIZE B	CODE IDENT NO. 11982	SK
MJO		SCALE		SHEET 1 OF

SYSTEMS 3663 REV. 12-71

Other Items of Test Equipment Used in this evaluation are listed below:

- External load with relay for over load short circuit testing.
- FLUKE 931V RMS DIFFERENTIAL VOLTMETER.
- HP Model 3465 Digital Multimeter.
- TEKTRONIX Model P6042 Current Probe.
- HP Model 310A Wave Analyzer.
- TEKTRONIX Model P6019 Current Probe.
- LEEDS & NORTHROP Model 8692-2 Temperature Potentiometer.
- TENNEY ENG. Model TT6-112350 Temperature Chamber.

8. DISCUSSION OF TEST RESULTS AND RECOMMENDATIONS.

Results obtained from testing of the two DC to DC Power Processors are discussed below.

1) Steady-State Performance. The test results show excellent performance in output voltage regulation, ripple, and current limiting.

2) Transient Response. Good transient response, control of inrush current limiting during starting and output short circuit were demonstrated. Also shown was, that Component Stress levels were controlled during turn-on, steady-state, and transient load and line conditions.

3) Thermal Control. The continuous duty and temperature tests indicated good thermal control of the front panel temperature as well as individual component temperatures.

9. CONCLUSIONS.

The DC-DC Power Processor test program demonstrated that the units met internal component transient control and that all transient and steady-state performance data met the Technical Guidelines of the DAAB07-78-C-2988 contract with the exceptions of the EMI tests (see EMI test report) and the full load to no load recovery time requirement.

The temperature testing demonstrated that the power components temperatures were controlled in this mechanical design, such that under the worst case, all temperatures remained within safe limits.

10. SUMMARY OF THE TEST DATA

DC TO DC POWER PROCESSOR PERFORMANCE

a) Regulation and Efficiency

V_{INPUT} (VDC)	I_{INPUT} (ADC)	I_{INPUT} (mA AC)	P_{INPUT} (WATTS)	V_{OUTPUT} (VDC)	I_{OUTPUT} (ADC)	RIPPLE (mVP-P)	P_{OUTPUT} (WATTS)	EFF. (%)	VOLTAGE SETTING	CURRENT SETTING
20	9.9	<5	198.0	28.00	6	100	168.78	85.2	28	5.0
28	7.5		210.0	28.01		110	168.84	80.4		5.0
40	5.4		216.0	28.01	6	160	168.14	77.8		5.0
20	55.2		1104.0	27.99	34.8	100	1000.15	90.6		35.0
28	39.3		1100.4	28.00	34.6	100	994.75	90.4		35.0
40	27.3		1092.0	28.01	34.6	120	994.75	91.1		35.0
20	128.7		2574.0	27.98	74.8	280	2216.3	86.1		75.0
28	90.6		2536.8	27.98	74.8	280	2217.8	87.4		75.0
40	63.3		2532.0	27.99	74.6	250	2212.6	87.4		75.0
20	7.5		150.0	24.00	5.2	90	125.37	83.6	24	5.0
40	3.9		156.0	24.01	5.2	150	125.42	80.4	24	5.0
20	111.9		2238	23.99	75	240	1922.3	85.9	24	75.0
40	55.4		2216	23.99	74.8	210	1917.9	86.5	24	75.0
20	6		120.0	32.03	3	100	96.27	80.2	32	5.0
40	3.3		132.0	32.04	3	150	96.3	73.0	32	5.0
20	145.5		2910.0	32.00	75	400	2524.5	86.8	32	75.0
40	71.4	<5	2856.0	32.02	75	250	2525	88.4	32	75.0

DATE OF TEST: 8/15/80
TECHNICIAN : S.A

Test: Room Temperature

UNIT SERIAL NO. 001
AMBIENT TEMPERATURE 75°F

DC TO DC POWER PROCESSOR PERFORMANCE

a) Regulation and Efficiency

V_{INPUT} (VDC)	I_{INPUT} (ADC)	I_{INPUT} (mA AC)	P_{INPUT} (WATTS)	V_{OUTPUT} (VDC)	I_{OUTPUT} (ADC)	RIPPLE (mVP-P)	P_{OUTPUT} (WATTS)	EFF. (%)	VOLTAGE SETTING	CURRENT SETTING
20	10.2	<5	204	28.08	6	20	169.2	82.9	28	5.0
28	7.5		210	28.08	6	30	169.26	80.6		5.0
40	5.4		216	28.08	6	40	169.26	78.36		5.0
20	55.2		1104	28.07	34.8	40	1003.63	90.9		35.0
28	39.3		1100.4	28.07	34.8	40	1003.63	91.2		35.0
40	27.6		1100.4	28.08	34.8	50	1003.53	91.2		35.0
20	12.81		2562	28.05	75	60	2232	87.1		75.0
28	90.3		2528.4	28.05	75	80	2232	88.3		75.0
40	63	<5	2520	28.05	75	100	2232	88.6		75.0

DATE OF TEST: 8/21/80
TECHNICIAN : S.A

Test: Cold Temperature -32°C

UNIT SERIAL NO. 001
AMBIENT TEMPERATURE -26°F

DC TO DC POWER PROCESSOR PERFORMANCE

a) Regulation and Efficiency

V_{INPUT} (VDC)	I_{INPUT} (ADC)	I_{INPUT} (mA AC)	P_{INPUT} (WATTS)	V_{OUTPUT} (VDC)	I_{OUTPUT} (ADC)	RIPPLE (mVP-P)	P_{OUTPUT} (WATTS)	EFF. (%)	VOLTAGE SETTING	CURRENT SETTING
20	9.9	<5	198	28.04	6	35	169.02	85.4	28	5.0
28	7.2		201.6	28.05	6	30	169.08	83.87		5.0
40	5.1		204	28.06	6	40	169.14	82.9		5.0
20	55.2		1104	28.04	34.6	40	997.52	90.4		35.0
28	39.3		1100.4	28.04	34.6	55	997.52	90.7		35.0
40	27.6		1104	28.05	34.6	60	997.86	90.4		35.0
20	131.4		2628	27.94	75	60	2227.5	84.8		75.0
28	92.1		2578.8	27.95	74.8	90	2221.56	86.1		75.0
40	64.2	<5	2568	27.96	75	90	2228.25	86.8		75.0

DATE OF TEST: 8/20/80
TECHNICIAN : S.A.

Test: High Temperatures

UNIT SERIAL NO. 001
AMBIENT TEMPERATURE +145°F

CONTINUOUS DUTY

INPUT VDC	ADC	E_0 VDC	LOAD ADC	I_0 ADC	E_0 (VDC)				
					6 hr	8 hr	16 hr	24 hr	72hr
28	90.9	28	75	75.0	28.02		28.0		
	91.5			75.0					
	91.8			75.0				27.99	
	91.5			75.0					28.00

TEST: *DC VOLTAGE VARIATION OVER 72 HR. TEST.*

DATE: 9/3/80 SERIAL NO. 001

ENGINEER: SID ADLIN TECHNICIAN: SID ADLIN

STABILITY

	INPUT		E_0	LOAD	E_0	I_0
START OF	VDC	ADC	VDC	ADC	VDC	ADC
24 HR.	20	0.6	28	0	28.04	0
TEST	20	61.2		37.5	28.03	38.4
	20	129		75	28.01	75
	28	0.6		0	28.05	0
	28	43.5		37.5	28.03	38.4
	28	90.9		75	28.02	75
	40	0.3		0	28.05	0
	40	30.6		37.5	28.04	38.4
	40	63.6		75	28.02	75
END OF	20	0.6	28	0	28.05	0
72 HR.	20	61.5		37.5	28.04	38.4
TEST	20	130.5		75	28	75
	28	43.8		37.5	28.04	38.4
	28	91.5		75	28.00	75
	28	0.3		0	28.06	0
	40	0.3		0	28.06	0
	40	30.9		37.5	28.05	38.4
	40	63.9		75	28.01	75

TEST: 0 HR.

TEST END 72 HR.

DATE: 9/3/80

SERIAL NO. 001

ENGINEER: Sid Adlin

TECHNICIAN: Sid Adlin

DC TO DC POWER PROCESSOR PERFORMANCE

a) Regulation and Efficiency

V_{INPUT} (VDC)	I_{INPUT} (ADC)	I_{INPUT} (mA AC)	P_{INPUT} (WATTS)	V_{OUTPUT} (VDC)	I_{OUTPUT} (ADC)	RIPPLE (mVP-P)	P_{OUTPUT} (WATTS)	EFF. (%)	VOLTAGE SETTING	CURRENT SETTING
20	9.6	<5	192	28.055	6	80	169	88.0	28	5.0
28	7.2		201.6	28.059	6	100	169	83.87		5.0
40	5.1		204	28.064	6	150	169.1	82.9		5.0
20	54.6		1092	28.045	34.6	100	996.83	91.3		35.0
28	39.0		1092	28.049	34.4	80	991.06	90.8		35.0
40	27.3		1092	28.053	34.4	120	991.06	90.8		35.0
20	129.3		2586	28.007	74.8	300	2221.56	85.9		75.0
28	90.9		2545.2	28.010	74.8	260	2221.56	87.3		75.0
40	63.6		2532	28.013	74.6	300	2216.37	87.5		75.0
20	7.2		144	24.006	5.2	80	125.32	87.0	24	5.0
40	3.9		156	24.013	5.2	140	125.32	80.4	24	5.0
20	112.2		2244	23.974	75	390	1923.75	85.7	24	75.0
40	55.2		2208	23.982	74.8	300	1919.37	86.9	24	75.0
20	5.7		114	32.05	3	100	96.3	84.5	32	5.0
40	3		120	32.06	3	160	96.3	80.3	32	5.0
20	145.3		2916	32.01	75	300	2526.75	86.7	32	75.0
40	71.4		2856	32.01	75	300	2528.25	88.5	32	75.0

DATE OF TEST: 10/15/80

TECHNICIAN : S.A

UNIT SERIAL NO. 002

AMBIENT TEMPERATURE +77°F

OVERSHOOT AND RECOVERY

INITIAL CONDITIONS		TERMINAL CONDITIONS		OVERSHOOT ABOVE 28. 28VDC INPUT VDC			RECOVERY M-SEC TO 28 VDC INPUT VDC		
E_0 (VDC)	I_0 (ADC)	E_0 (VDC)	I_0 (ADC)	20	28	40	20	28	40
0	0	28	75	0	0	0	0	0	0
0	0	28	0	0	0	0	0	0	0
28	0	28	75	-1 volt	-1 volt	-1 volt	1	1	1
28	75	28	0	+0.52	+0.52	+0.52	5000	5000	5000

TEST: LOAD & LINE VARIATION

DATE: 10/20/80 SERIAL NO. 002

ENGINEER: Sid Adlin TECHNICIAN: Sid Adlin

OVERSHOOT AND RECOVERY

INITIAL CONDITIONS		TERMINAL CONDITIONS		OVERSHOOT ABOVE 28. 28VDC INPUT VDC			RECOVERY M-SEC TO 28 VDC INPUT VDC		
E_0 (VDC)	I_0 (ADC)	E_0 (VDC)	I_0 (VDC)	20	28	40	20	28	40
0	0	28	75	0	0	0	0	0	0
0	0	28	0	0	0	0	0	0	0
28	0	28	75	(-2.0) 0	(-2.0) 0	(-2.0) 0	2	2	2
28	75	28	0	+1.72	+1.72	+1.72	17000	17000	1700

TEST: LOAD & LINE VARIATION

DATE: 10/20/80 SERIAL NO. 002

ENGINEER: Sid Adlin TECHNICIAN: Sid Adlin

NOTE: Readings taken 25' from unit (Remore Sense).

ACCELERATED STRESSES

Time On	V_{Input}	Time Off	Failures	Degradation
9:18 AM	41.34	9:35	None	None

Test Engineer: Sid Adlin Date: 10/20/80

Technician: Sid Adlin Serial No. 02

OVER LOAD PROTECTION

INPUT VDC	TEMP	READING	OUTPUT CURRENT / OUTPUT VOLTAGE ± 0.1 VDC						
			32	28	24	18	12	6	2.5
28	AMB	1	75.6	79.6	79.6	79.6	79.6	79.6	79.6
20		2	75.6	79.6	79.6	79.6	79.6	79.6	79.6
40		3	75.6	79.6	79.6	79.6	79.6	79.6	79.6

ENGINEER: S. Adlin S/N 002

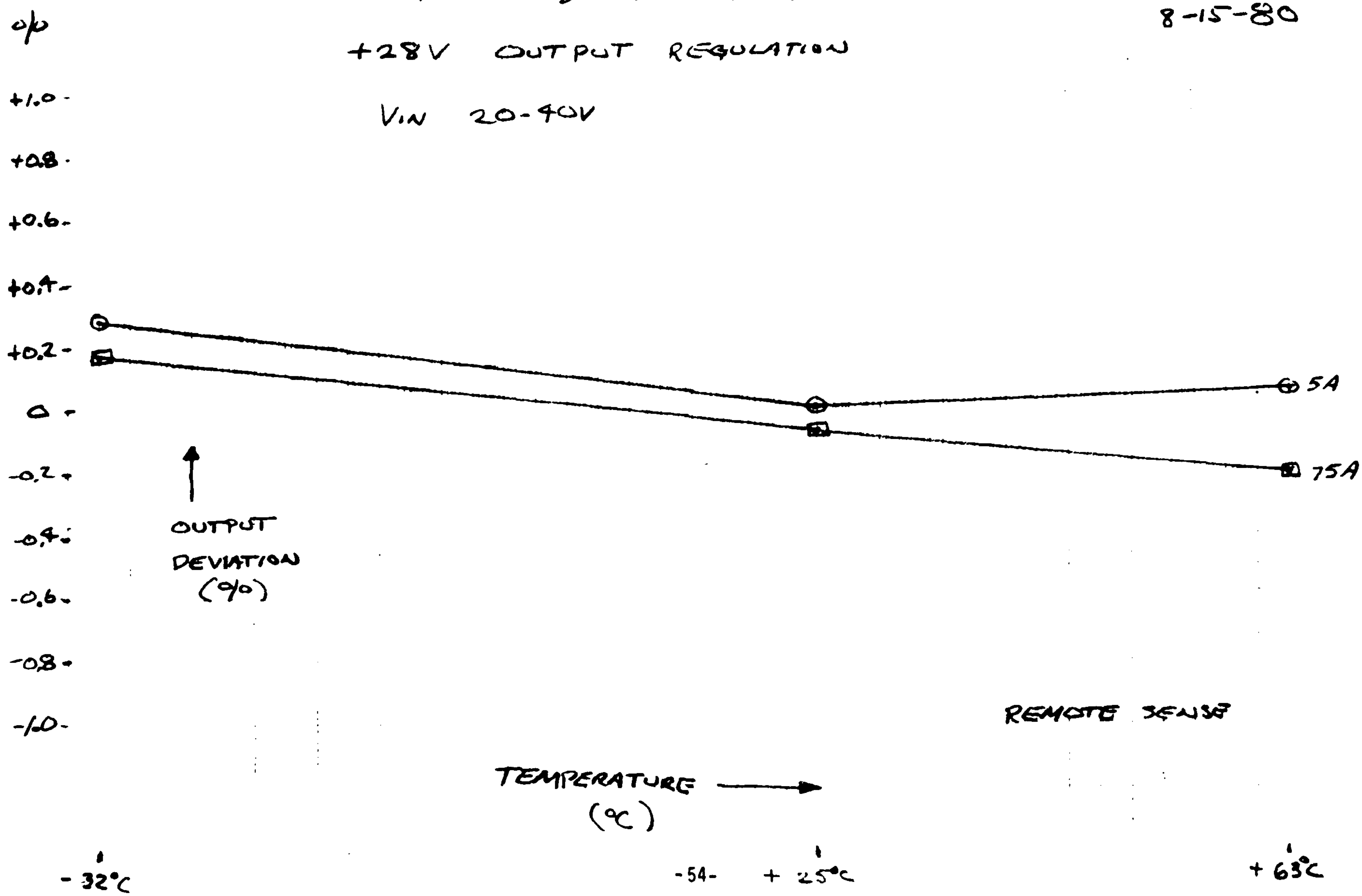
TEST: 10/20/80

DC TO DC POWER PROCESSOR

+28V OUTPUT REGULATION

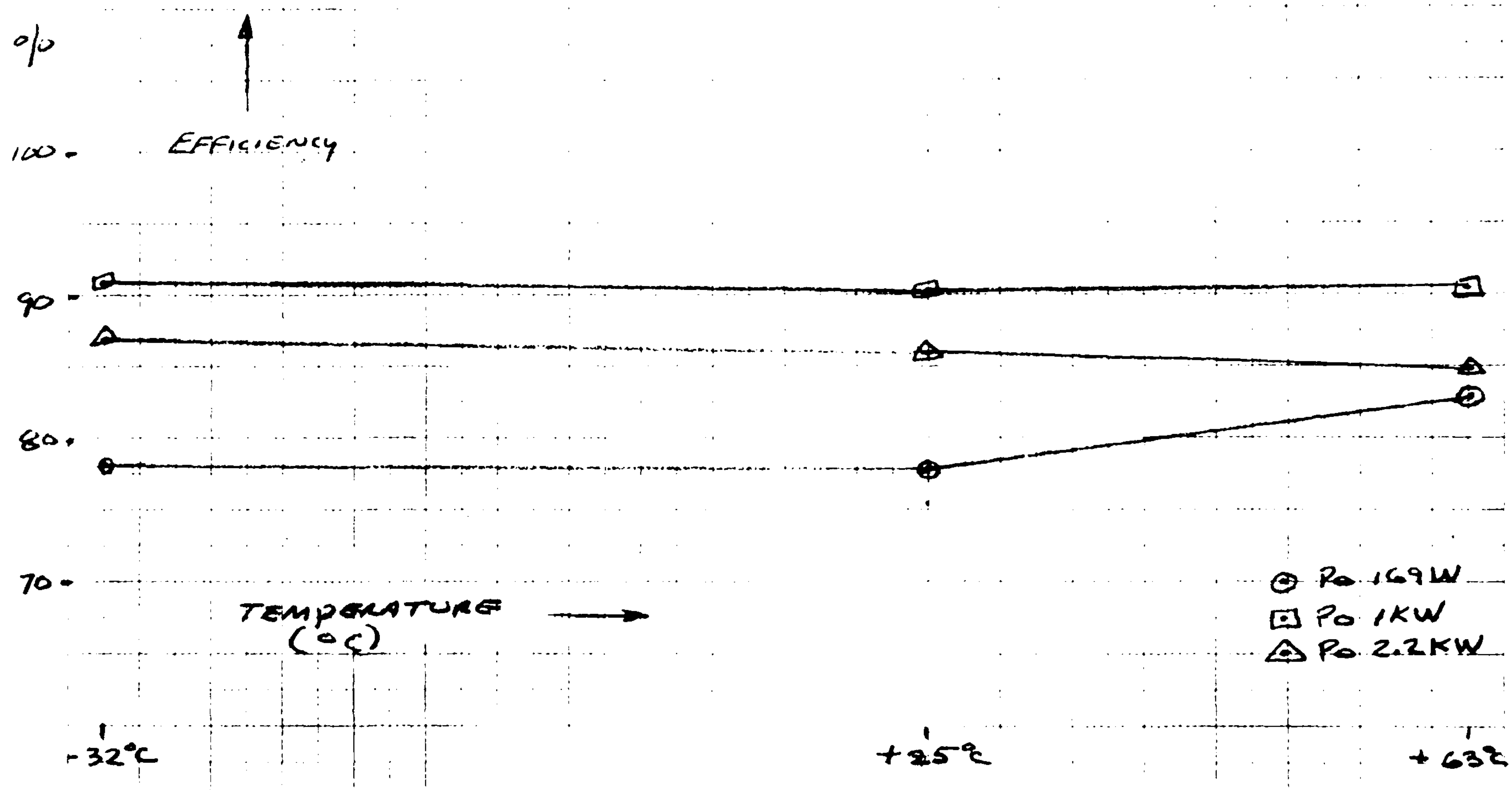
VIN 20-40V

8-15-80



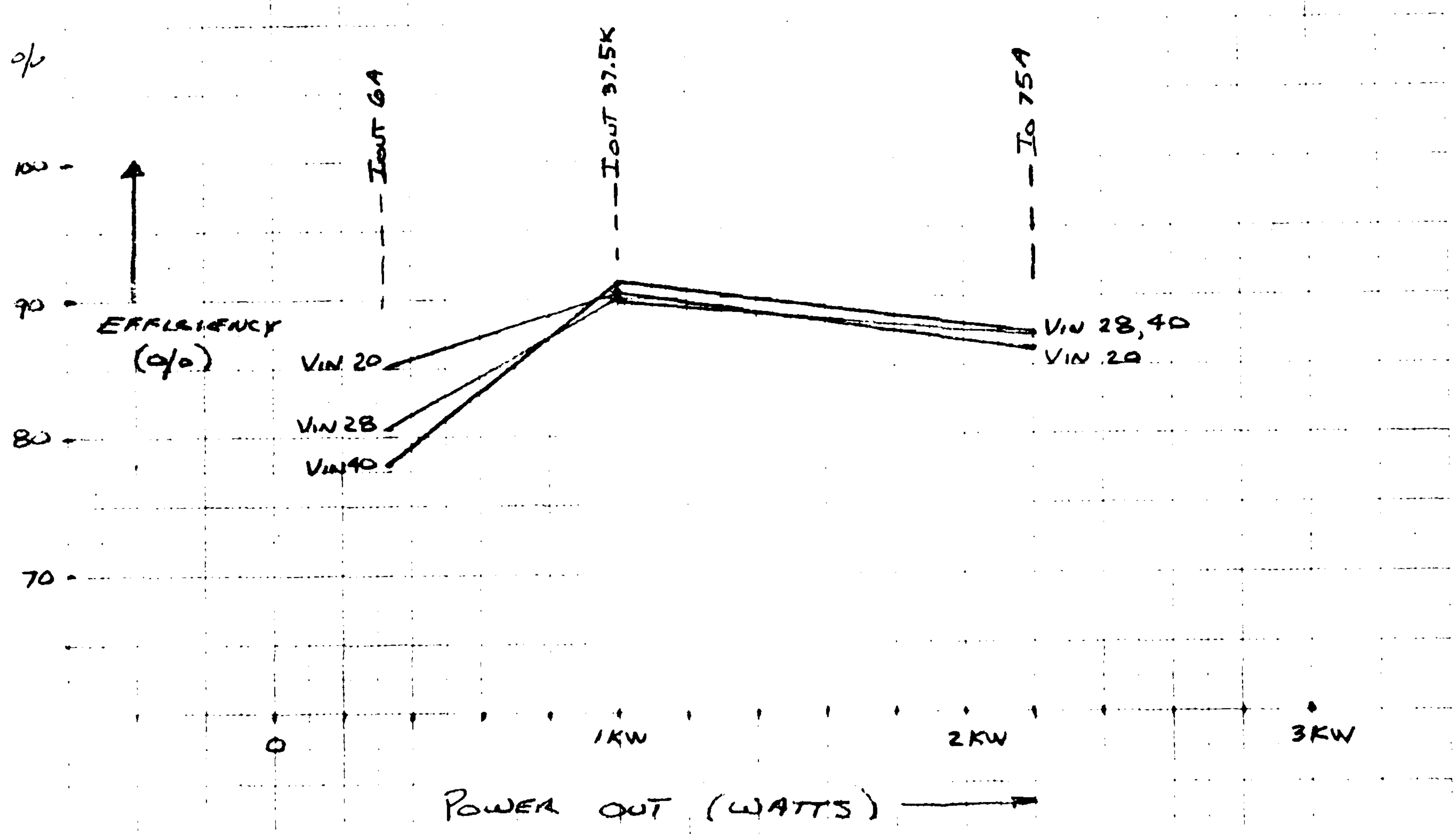
DC TO DC POWER PROCESSOR 8-20-80

EFFICIENCY VS POUT WITH TEMPERATURE



8-15-80

DC TO DC POWER PROCESSOR
EFFICIENCY VS POWER OUT
(AMBIENT TEMP)



Temperature Profile

A temperature test was performed in which fifteen internal temperatures were monitored. The results of these tests are summarized in tables II-1A thru II-1C.

Note: That at room ambient temperature, the outside front panel temperature reached 104°F (40°C) as compared to the 43°C maximim requirement as contained in the design guidelines.

TABLE II-1A (V_{IN}28, $V_0$28, $I_0$75A)
DC to DC Power Processor Temperature Profile at 77°F Ambient
(Component and Unit Temperatures at end of 72 hour test)

T.C. NO.	LOCATION	TEMP °F
1	Outside Ambient	77
2	Outside-Front Panel	104
3	Outside-Left Side-Opposite Front Rectifiers	139
4	Outside-Left Side-Adjacent Front Transistors	150
5	Outside-Right Side-Opposite back Rectifiers	136
6	Transformer-Left Side Body Front	178
7	PC Board Surface-Middle fiber board	157
8	Input Filter Capacitor-Floor bracket middle	135
9	Output Filter Capacitor-Floor Bracket Right	137
10	Right Side Front Rectifier case-Bracket for two	163
11	Left Side Transistor Case-Front	160
12	Air just below PC Board.	150
13	Flyback Inductor Front Body	169
14	Rear Panel Middle	126
15	Input Inductor on Body-Top	155

TABLE II-1B (V_{IN}28, $V_0$28, $I_0$75A)
DC-DC Power Processor Temperature Profile at T_{AMB}=145°F
(Component and Unit Temperatures After Stabilization)

T.C. NO	LOCATION	TEMP °F
1	Outside Ambient	145
2	Outside-Front Panel	145
3	Outside-Left Side-Opposite Front Rectifiers	157
4	Outside-Left Side-Adjacent Front Transistors	178
5	Outside-Right Side-Opposite back Rectifiers	167
6	Transformer-Left Side Body Front	206
7	PC Board Surface-Middle fiber board	185
8	Input Filter Capacitor-Floor bracket middle	161
9	Output Filter Capacitor-Floor Bracket Right	162
10	Right Side Front Rectifier case-Bracket for two	187
11	Left Side Transistor Case-Front	187
12	Air just below PC Board.	181
13	Flyback Inductor Front Body	200
14	Rear Panel Middle	163
15	Input Inductor on Body-Top	189

TABLE II-1C (V_{IN}28, V_O28, I_O75A)

DC-DC Power Processor Temperature at T_{AMB}=26°F

(Component and Unit Temperatures after Stabilization)

T.C. NO	LOCATION	TEMP°F
1	Outside Ambient	-26
2	Outside-Front Panel	-26
3	Outside-Left Side-Opposite Front Rectifiers	- 2
4	Outside-Left Side-Adjacent Front Transistors	6
5	Outside-Right Side-Opposite back Rectifiers	- 4
6	Transformer-Left Side Body Front	31
7	PC Board Surface-Middle fiber board	24
8	Input Filter Capacitor-Floor bracket middle	- 8
9	Output Filter Capacitor-Floor Bracket Right	- 8
10	Right Side Front Rectifier case-Bracket for two	23
11	Left Side Transistor Case-Front	16
12	Air just below PC Board.	12
13	Flyback Inductor Front Body	28
14	Rear Panel Middle	- 7
15	Input Inductor on Body-Top	17

OVERSHOOT AND RECOVERY

INITIAL CONDITIONS		TERMINAL CONDITIONS		OVERSHOOT ABOVE 28. 28VDC INPUT VDC			RECOVERY M-SEC TO 28 VDC INPUT VDC		
E_0 (VDC)	I_0 (ADC)	E_0 (VDC)	I_0 (VDC)	20	28	40	20	28	40
0	0	28	75	0	0	0	0	0	0
0	0	28	0	0	0	0	0	0	0
28	0	28	75	(-2V) 0	(-2V) 0	(-2V) 0	2	2	2
28	75	28	0	0.4	0.4	0.4	5000	5000	5000

TEST: *LOAD & LINE VARIATION*

DATE: 10/2/80 SERIAL NO. 01

ENGINEER: S. Adlin TECHNICIAN: ______

NOTE: Readings taken at output connector (Local Sense).

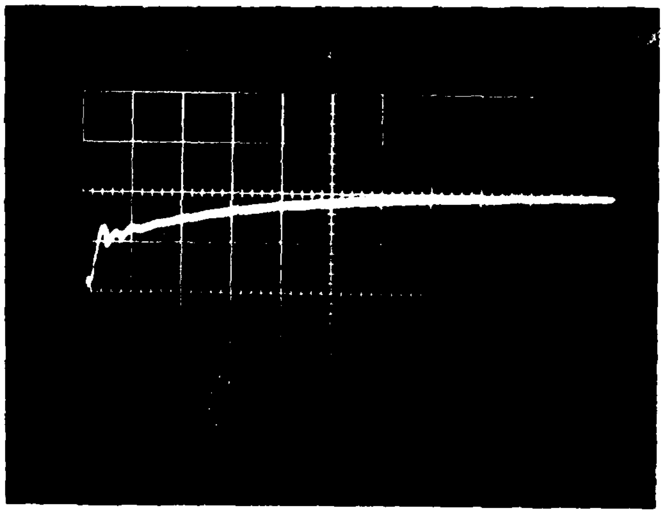
9-26-80

0-75A STEP LOAD

V_{INPUT} = 28VDC

Vert = 0.5V/cm

Horiz = 5msec/cm

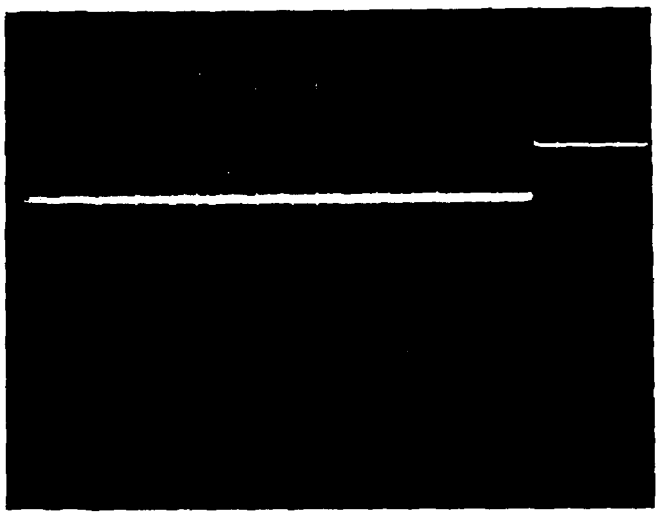


75 to 0A STEP LOAD

V_{INPUT} = 28VDC

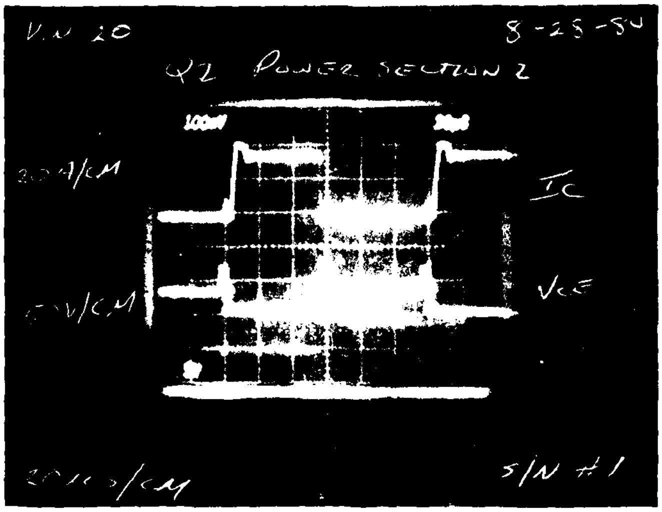
Vert = 0.5V/cm

t = 20msec/cm



SWITCHING WAVEFORMS

V_0 28 I_0 75A

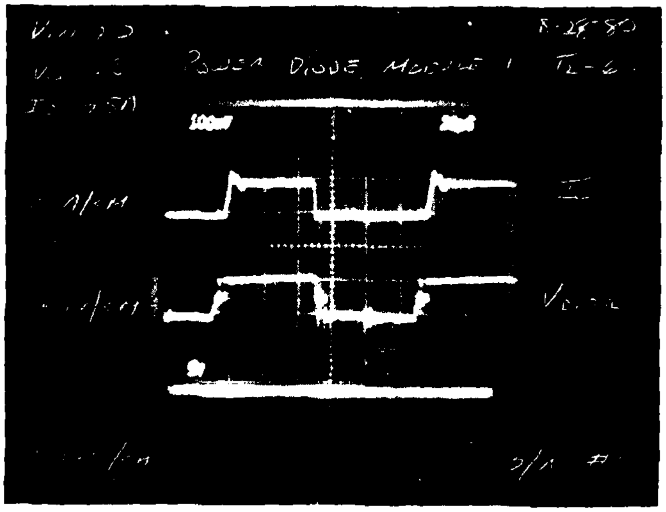


Q2 POWER XSTR
MODULE 2

I_{COL} : 20A/cm

V_{CE} : 50V/cm

20us/cm



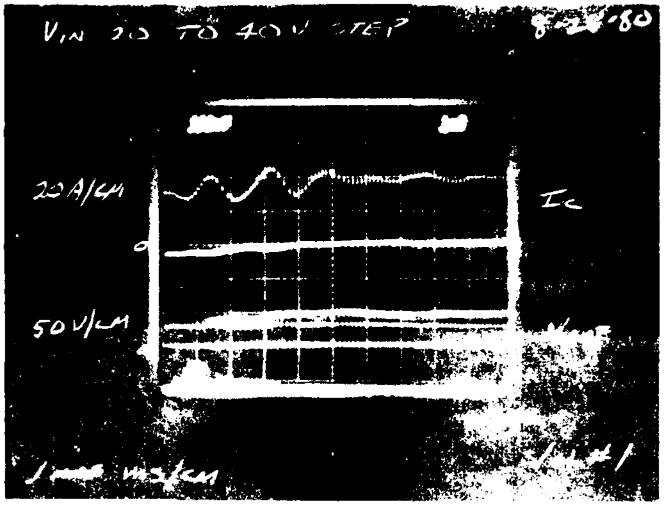
POWER DIODE
MODULE 1

I_{DIODE} : 20A/cm

V_{piv} : 50V/cm

20us/cm

40V STEP

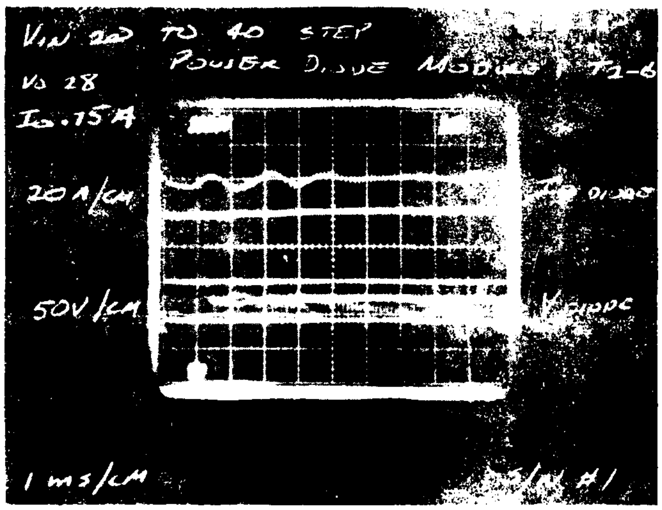


Q2 POWER XSTR
MODULE #2

I_C 20A/cm

V_{CE} 50V/cm

1ms/cm

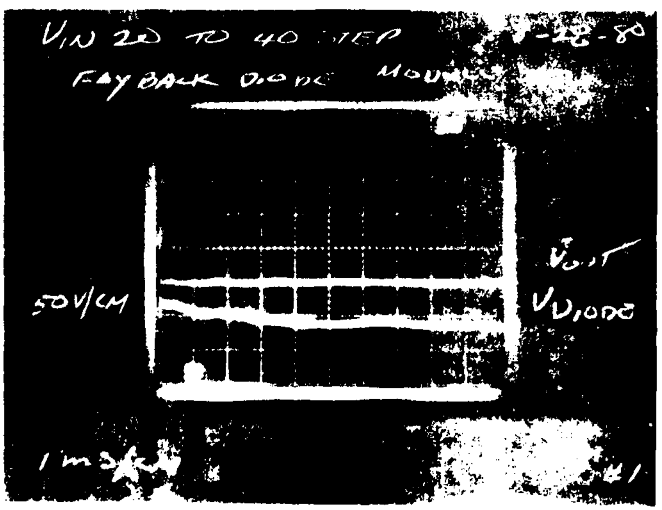


POWER DIODE
MODULE #1

Io_{DIODE} 20A/cm

V_D 50V/cm

1ms/cm



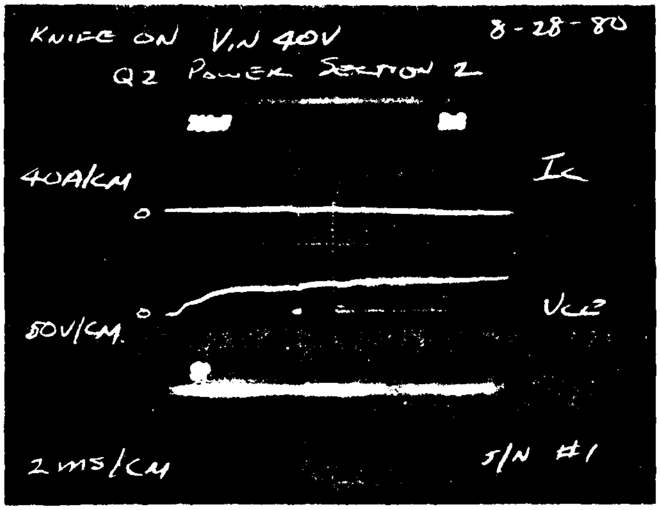
POWER DIODE
(FLYBACK)
MODULE #2

V_D 50V/cm

1ms/cm

4 W KNIFE OF TRANSIENT

V_O 28 I_O 75A

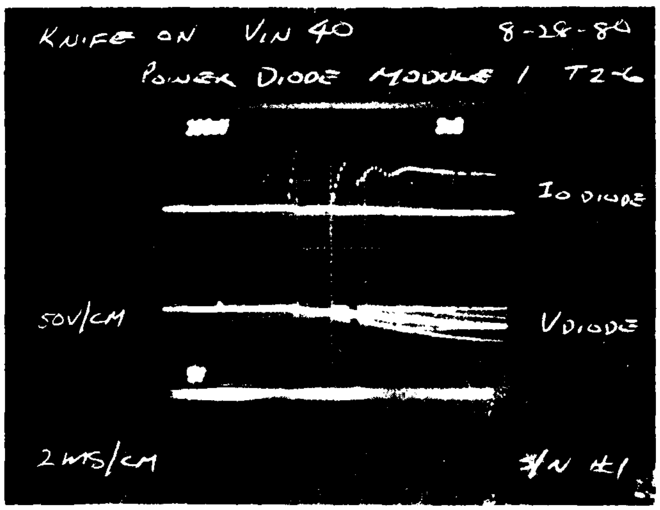


Q2 POWER XSTR MODULE #2

I_C : 40A/cm

V_{CE} : 50V/cm

2ms/cm

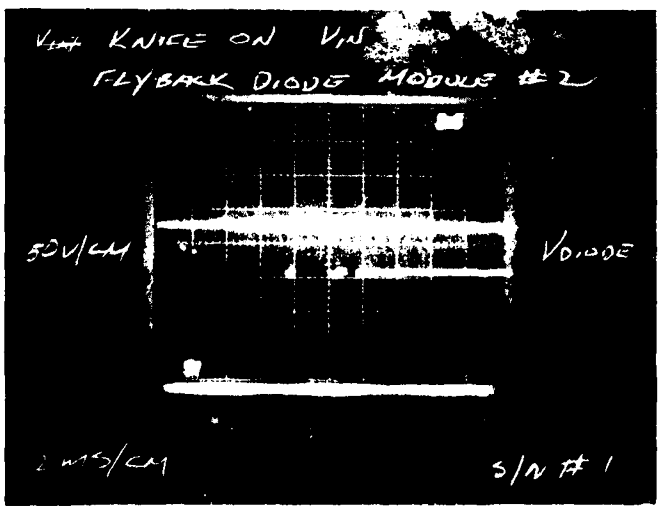


POWER DIODE MODULE #1

$I_{O_{DIODE}}$: 20A/cm

V_{piv} : 50V/cm

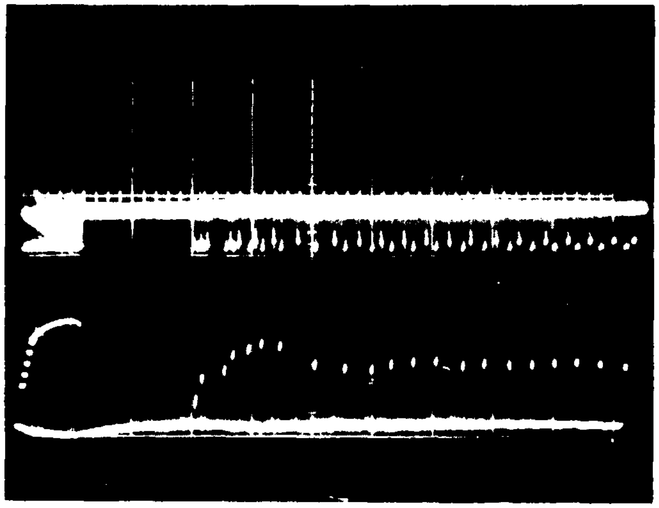
2ms/cm



OUTPUT POWER DIODE - MODULE #2

50V/cm

10-3-80



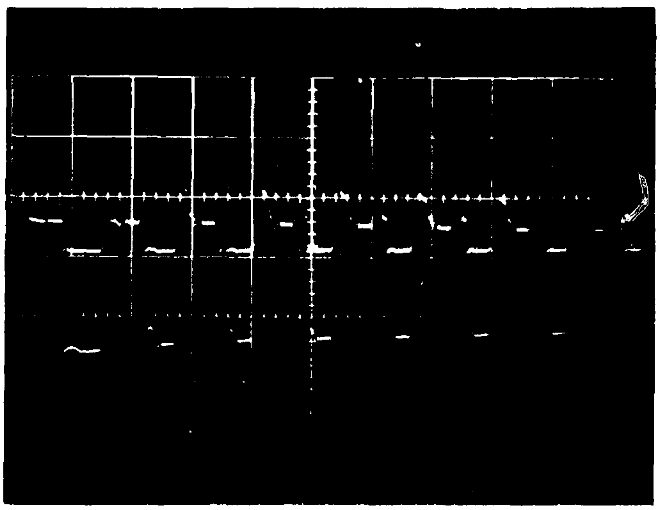
NO LOAD TO A SHORT

V_{IN} 28

V_{CE} 50V/cm

I_{COL} 40A/cm

2ms/cm



NO LOAD TO A SHORT

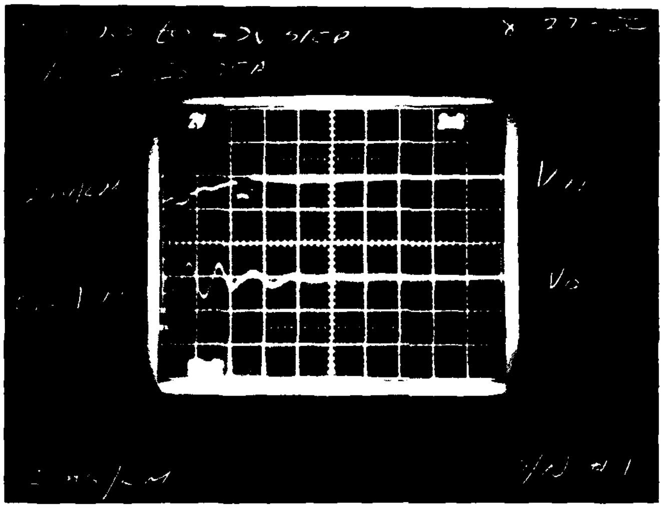
V_{CE} 50V/cm

I_{COL} 40A/cm

50ms/cm

V_{IN} 20 TO 40V STEP (TRANSIENT)

V_{OUT}



V_{IN} : 20V/cm

V_O : 0.5V/cm

2ms/cm

APPENDIX

Parts List

These lists contain component information and represents the parts used in the two development models.

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
38				LM101AH		IC (OP-AMP)		U101 U102	1
112				SE555T		IC (TIMER)		U103	2
10				CD4018BD		IC (COUNTER)		U104	3
20				LM139AD		IC (VOLTAGE COMPARATOR)		U105	4
									5
									6
									7
10				1N4573A		ZENER DIODE 6.4V (TC)		VR101 VR102	8
									9
									10
									11
16				1N5811		DIODE 6A, 150V		CR101,102 103,104	12
16				1N5806		DIODE 2.5A, 150V		CR105,106 107,108	13
2				1N5806		DIODE 2.5A, 150V		CR109,110	14
				1N5811				CR114,115 116,112	15
									16
<1				CK06BX103K		CAPACITOR, .01µf/200V		C101,109	17

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

$\Sigma P_{diss} = 629\,mW$

SIZE	FSCM NO.		REV.
A	11982	INPUT/OUTPUT SENSE ELECTRONICS DC to DC POWER PROCESSOR	
5-29-81		SHEET 1 of 4	

SYSTEMS 2444 REV. 2-1-77

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				CK06BX104K M39014/02-1270		CAPACITOR, .1μf/100V	MIL-C-39014	C102 C105	18
<1				M39014/02-1246		CAPACITOR, 2200pf, 200V	MIL-C-39014	C103	19
<1				CK05BX330K M39014/01-1330		CAPACITOR, 33pf, 200V	MIL-C-39014	C104 C108	20
<1				UY03471J		CAPACITOR, 470pf, ±1%,100V	1A015-284V-311	C107	21
10				M39003/01-2764		33μfd/20V CAPACITOR	MIL-C-39003	C106	22
									23
									24
									25
28				RNC55H3012FR		30.1K, 1%, 125mW RESISTOR	MIL-R-55182	R101	26
<1				RNC55H3012FR		30.1K, 1%, 125mW RESISTOR		R102	27
5				RNC55H2050FR		205Ω, 1%, 1/8W		R103	28
<1				RNC55H1001FS		1K, 1%, 1/8W		R104	29
<1				RNC55H4992FR		49.9K, 1%, 1/8W		R105	30
3				RNC55HXXXXFR		SIT, 1%, 1/8W	MIL-R-55182	R106	31
5				RA20LASB2524		2.5K, Pot	MIL-R-19/2	R107	32
3				RNC55H9531FR		9.53K, 1%, 1/8W	MIL-R-55182	R108	33
<1				RNC55H2492FS		24.9K, 1%, 1/8W	MIL-R-55182	R109	34

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INPUT/OUTPUT SENSE ELECTRONICS DC TO DC POWER PROCESSOR	
		SHEET 2 of 4	

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
3.5				RNC55H3481FR		3.48K, 1%, 1/8W RESISTOR		R110	35
3				RNC55H3011FS		3.01K, 1%, 1/8W		R111	36
<1				RNC55H2492FR		24.9K, 1%, 1/8W		R112	37
40				RA20LASB252A		2.5K POT	MIL-R-19/2	R113	38
4.3				RNC55HXXXXFR		SIT, 1%, 1/8W		R114	39
<1				RNC55H4421FS		4.47K, 1%, 1/8W		R115	40
<1				RNC55H1002FS		10K, 1%, 1/8W		R116	41
<1				RNC55H5622FS		56.2K, 1%, 1/8W		R117	42
<1				RNC55H2942FS		29.4K, 1%, 1/8W		R118	43
<1				RNC55H5111FR		5.11K, 1%, 1/8W		R119	44
<1				RNC55H1002FS		10K, 1%, 1/8W		R120	45
100				RWR80S1211FR RWR81S1211FR		1.21K, 1%, 1W		R121	46
<1				RNC55H1002FS		10K, 1%, 1/8W		R122	47
<1				RNC55H5122FR		51.1K, 1%, 1/8W		R123	48
<1				RNC55H4022FR		40/2, 1%, 1/8W		R124	49
2				RNC55H4021FR		4.02K, 1%, 1/8W		R125	50
<1				RNC55H1001FR		.1K, 1%, 1/8W RESISTOR		R126	51

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DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INPUT/OUTPUT SENSE ELECTRONICS DC TO DC POWER PROCESSOR	
		SHEET 3 of 4	

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
3.5				RNC55H3481FR		3.48K, 1%, 1/8W RESISTOR		R110	35
3				RNC55H3011FS		3.01K, 1%, 1/8W		R111	36
<1				RNC55H2492FR		24.9K, 1%, 1/8W		R112	37
40				RA20LASB252A		2.5K POT	MIL-R-19/2	R113	38
4.3				RNC55HXXXXFR		SIT, 1%, 1/8W		R114	39
<1				RNC55H4421FS		4.47K, 1%, 1/8W		R115	40
<1				RNC55H1002FS		10K, 1%, 1/8W		R116	41
<1				RNC55H5622FS		56.2K, 1%, 1/8W		R117	42
<1				RNC55H2942FS		29.4K, 1%, 1/8W		R118	43
<1				RNC55H5111FR		5.11K, 1%, 1/8W		R119	44
<1				RNC55H1002FS		10K, 1%, 1/8W		R120	45
100				RWR80S1211FR RWR81S1211FR		1.21K, 1%, 1W		R121	46
<1				RNC55H1002FS		10K, 1%, 1/8W		R122	47
<1				RNC55H5122FR		51.1K, 1%, 1/8W		R123	48
<1				RNC55H4022FR		40/2, 1%, 1/8W		R124	49
2				RNC55H4021FR		4.02K, 1%, 1/8W		R125	50
<1				RNC55H1001FR		.1K, 1%, 1/8W RESISTOR		R126	51

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DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INPUT/OUTPUT SENSE ELECTRONICS DC TO DC POWER PROCESSOR	
		SHEET 3 of 4	

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				RNC55H4022FS		40.2K, 1%, 1/8W RESISTOR	MIL-R-44182	R127	52
37				RNC55H3402FR		34K, 1%, 1/8W		R128	53
8				RNC55H6651FS		6.65K, 1%, 1/8W		R129	54
<1				RNC55HXXXXFR		SIT, 1%, 1/8W		R130	55
<1				RNC55H4022FS		40.2K, 1%, 1/8W		R131	56
<1				RNC55H4022FS		40.2K, 1%, 1/8W		R132	57
160				RWR81SXXXFR		SIT, 1%, 1W	MIL-R-39007	R133	58
									59
									60
									61
10				T1745		PULSE TRANSFORMER		T101	62
10				T1734		ASDTIC TRANSFORMER		T102	63
									64
									65
									66
									67
									68

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SIZE	FSCM NO.		REV.
A	11982	INPUT/OUTPUT SENSE ELECTRONICS DC TO DC POWER PROCESSOR	

SHEET 4 of 4

SYSTEMS 2444 REV. 1-77

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
90				2N5154		TRANSISTOR (NPN)		Q1	1
90				2N5154		TRANSISTOR (NPN)		Q2	2
13580				55EJ106		TRANSISTOR POWER	1P241-001	Q3	3
13580				55EJ106		TRANSISTOR POWER	1P241-001	Q4	4
<10				2N2907A		TRANSISTOR (PNP)		Q5	5
									6
									7
									8
24				1N5811	260	DIODE 6A, 150V		CR1	9
24				1N5811	260	DIODE 6A, 150V		CR2	10
3656				SCDA2F		DIODE 200V, 5A	SEMTECH	CR3 CR5	11
4480				SCDA2F		DIODE 200V, 5A	SEMTECH	CR4 CR6	12
50				1N5811	260	DIODE 6A, 150V		CR7	13
50				1N5811	260	DIODE 6A, 150V		CR8	14
18750						DIODE [illegible]	SEMTECH	CR9, CR10 CR11	15
100				1N5811	260	DIODE 6A, 150V		CR12	16
									17

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

$\Sigma P_{diss} = 81.13W$

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
4-6-79		SHEET 1 of 6	

SYSTEMS 444 REV. [illegible]

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
									18
				SN54LS221J	274	IC (MULTIVIBRATOR)	1H592-001V	U1	19
10				SN54LS001F	273	IC (4-INPUT NAND GATE) Quad 2-Input		U2	20
10				LM139AD	273	IC (VOLTAGE COMPARATOR)		U3	21
				LM140AK		IC (VOLTAGE REGULATOR)		U4	22
10				SN54LS20J	273	IC (4-INPUT NAND GATE) Dual 4-Input		U5	23
10				SN54LS00F	273	IC (4-INPUT NAND GATE) Quad 2-Input		U6	24
25				SE555T	113	IC (TIMING CIRCUIT)		U7	25
				55452B-JG		IC (TTL, DUAL NAND)		U8	26
									27
									28
									29
<1				M39014/02-1350	324	.1µfd/100V CAPACITOR		C1	30
<1				UY SERIES		180pfd ±2%, 100V CAPACITOR	1A015-245V-311	C2	31
<1				UY SERIES		180pfd ±2%, 100V CAPACITOR	1A015-245V-311	C3	32
<1				M39003/01-2769	281	15µfd/20V CAPACITOR		C4	33
<1				M39003/01-2769	281	15µfd/20V CAPACITOR		C5	34

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DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
		SHEET 2 of 6	

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				M39014/02-1350	324	.1μfd/100V CAPACITOR		C6	35
<1				CYFR20512A		5100pfd ±1%, 300V CAPACITOR	1A008-070V-314	C7	36
<1				M39014/02-1350		.1μfd/100V CAPACITOR		C8	37
<1								C9	38
<1								C10	39
<1				M39014-02-1350		.1μfd/100V		C11	40
100				91F148BNA		2800μfd/55V		C12	41
100								C13	42
100								C14	43
100						BRACKETS FOR 2800μfd.		C15	44
100								C16	45
100				91F148BNA		2800μfd/55V		C17	46
								C18	47
								C19	48
<1				M39014/02-1258		.01μfd/200V		C20	49
<1				M39014/02-1258		.01μfd/200V		C21	50
500				CB12D474KX7		.47/200 CAPACITOR		C22	51

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DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
		SHEET 3 of 6	

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
500						.5/200V CAPACITOR		C23	52
10				91F148BHA		2800μfd/55V CAPACITOR		C24	53
10				91F148BHA		2800μfd/44V CAPACITOR		C25	54
<1				39014/01-1259		100μfd/200V CAPACITOR		C26	55
									56
									57
6.5				RCR05G202JS		2K,5%, 1/8W RESISTOR		R1	58
6.5				RCR05G202JS		2K,5%, 1/8W RESISTOR		R2	59
<1				RCR05G103JS		10K,5%, 1/8W RESISTOR		R3	60
<1				RCR05G103JS		10K,5%, 1/8W RESISTOR		R4	61
<1				RNC55H1582FS		15.8K, 1%, 1/8 RESISTOR		R5	62
<1				RNC55H1002FS		10K, 1%, 1/8 RESISTOR		R6	63
<1				RNC55H3922FR		39.2K,1%,1/8 RESISTOR		R7	64
<1				RNC55HXXX1FR		SIT,10%,1/8 RESISTOR		R8	65
<1				RBR56L48701BR RCR56L47501BR		47.5K, 1/8W,1% RESISTOR		R9	66
<1				RCR05G103JS		10K,5%, 1/8 RESISTOR		R10	67
3				RNC55H2211FS		2.21K, 1%, 1/8 RESISTOR		R11	68

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
		SHEET 4 of 6	

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				RNC55H4992FR		49.9K, 1%, 1/8W RESISTOR		R12	69
3				RNC55H2211FS		2.21K, 1%, 1/8W RESISTOR		R13	70
102				RWR81S1926FR		19.6Ω, 1%, 1W RESISTOR		R14	71
				RCR20G201JS		200Ω, 5%, 1/2W RESISTOR		R15	72
				RCR20G201JS		200Ω, 5%, 1/2W RESISTOR		R16	73
				RCR20G201JS		200Ω, 5%, 1/2W RESISTOR		R17	74
				RCR20G201JS		200Ω, 5%, 1/2W RESISTOR		R18	75
				RWR80S10000FR		100Ω, 1%, 2W RESISTOR		R19	76
				RWR80S10000FR		100Ω, 1%, 2W RESISTOR		R20	77
20				RCR05G101JS		100Ω, 5%, 1/8W RESISTOR		R21	78
20				RCR05G101JS		100Ω, 5%, 1/8W RESISTOR		R22	79
<15				RCR20G103JS		10K, 5%, 1/2W RESISTOR		R23,R24 R27	80
<1				RNC55H4991FR		4.99K,1%,1/8W RESISTOR		R25	81
				RCR05G561JS		560Ω, 5%, 1/8W RESISTOR		R26	82
199				L-1492		INDUCTOR, SPIKE SUPPRESSION		L1	83
									84
10000				L-1473D		INDUCTOR,		L3	85

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
		SHEET 5 of 6	

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
								T1	86
105				T-1738-A		TRANSFORMER-CURRENT DRIVE		T2	87
105				T-1738-A		TRANSFORMER-CURRENT DRIVE		T3	88
<10				T-1733-A		TRANSFORMER-PEAK CURRENT SENSE		T4	89
<10				T-1733-A		TRANSFORMER-PEAK CURRENT SENSE		T5	90
12127				T-1739-A		TRANSFORMER POWER		T6	91
<10				T-1788		TRANSFORMER-PEAK CURRENT SENSE		T7	92
									93
									94
									95
									96
									97
									98
									99
									100
									101
									102

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	1/2 POWER MODULE DC-DC POWER PROCESSOR	
		SHEET 6 of 6	

SYSTEMS 2444 REV 2-1-72

CONFIGURATION				PARTS LIST					
P_{diss}	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				2N3700		TRANSISTOR, 1A/80V (NPN)			1
				2N5005		TRANSISTOR, 5A/80V (PNP)			2
				2N3637		TRANSISTOR (NPN)			3
10				2N3700		TRANSISTOR, 1A/80V (NPN)			4
				2N5154		TRANSISTOR (NPN)			5
34				2N5154		TRANSISTOR (NPN)			6
									7
									8
									9
				1N756A		DIODE, ZENER			10
				1N4573A		DIODE, ZENER			11
									12
									13
									14
17				1N5290A		DIODE, CONSTANT CURRENT(.47mA)			15
5.6				1N5806		DIODE, 3A/150V			16
				1N5816		DIODE, 15A/150V			17

$\Sigma P_{diss} = 3341\text{mW}$

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INTERNAL POWER SUPPLY DC TO DC POWER PROCESSOR	
4-6-79		SHEET 1 of 4	

SYSTEMS 2444 REV. 10-77

CONFIGURATION				PARTS LIST					
	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
4				1N5806		DIODE 3A/150V			18
7				1N5806		DIODE 3A/150V			19
4				1N5811		DIODE 6A/160V			20
7				1N5811		DIODE 6A/150V			21
7				1N5811		DIODE 6A/150V			22
4				1N5811		DIODE 6A/150V			23
									24
									25
									26
30				LM111H		IC, COMPARATOR			27
									28
									29
									30
47				M39003/01-2661		15μ fd/75V CAPACITOR			31
< 1				M39003/01-2532		33μ fd/20V CAPACITOR			32
< 1				M39003/01-2596		1 μ fd/50V CAPACITOR			33
14				M39003/01-2781		100μ fd/20V CAPACITOR			34

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INTERNAL POWER SUPPLY DC TO DC POWER PROCESSOR	
4-6-79		SHEET 2 of 4	

CONFIGURATION				PARTS LIST					
	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				M39003/01-1332		4700 μfd/200V CAPACITOR			35
<1				M39003/01-2532		33μfd/20 CAPACITOR			36
<1				M39003/01-2620		22μfd/50V			37
									38
									39
									40
10				RNC55H1000FS		100 Ω, 1%, 1/8W RESISTOR			41
4				RNC55H1001FS		1K, 1%, 1/8W RESISTOR			42
				RNR80S1001FS		1K, 1%, 2W RESISTOR			43
9				RNC55H1002FR		10K, 1% RESISTOR			44
1				RNC55H4122FS		41.2K, 1%, 1/2W RESISTOR			45
<1				RNC55H5111FR		5.11K, 1%, 1/2W RESISTOR			46
6				RNC55H3741FS		3.74K, 1%, 1/2W RESISTOR			47
7				RNC55H4751FS		4.75K, 1%, RESISTOR			48
2.3				RNC55HXXXXFR		SIT, 1% RESISTOR			49
4.5				RNC55H3011FR		3.01K, 1%, RESISTOR			50
5				RNC55H2871FR		2.87K, 1%, RESISTOR			51

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INTERNAL POWER SUPPLY DC TO DC POWER PROCESSOR	
	4-6-79	SHEET 3 of 4	

CONFIGURATION				PARTS LIST					
	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
<1				RNC55H1001FS		1K, 1/8W, 1% RESISTOR			52
37				RNC8052R00FR		2Ω , 1W, 1% RESISTOR			53
13				RNC55H1002FS		10K, 1/8W,1% RESISTOR			54
6				RCR076200JS		20Ω 1/8W, 5% RESISTOR			55
13				RNC55H1002FR		10K, 1/8W, 1% RESISTOR			56
11				RWR81S3010FR		301Ω , 1W, 1% RESISTOR			57
11				RWR81S3010FR		301Ω , 1W, 1% RESISTOR			58
127				RWR81S1001FR		1K, 1W, 1W, 1% RESISTOR			59
									60
									61
									62
				<-1519A		INDUCTOR, AVERAGING CHOKE			63
									64
									65
									66
				T-1735E		TRANSFORMER, POWER			67
									68

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	INTERNAL POWER SUPPLY DC TO DC POWER PROCESSOR	
		SHEET 4 of 4	

AD-A107 676 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CA --ETC F/G 10/2
TWO POINT FOUR KW DC/DC CONVERTER REGULATOR.(U)
OCT 81 R E EGGERT DAAB07-78-C-2988

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CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
				AM1516-130-50DC-1		150A SINGLE POLE BREAKER	HEINMANN		1
				2XAM1516-100		100A Z POLE BREAKER	HEINMANN		2
									3
									4
				5226-8941		100MV FULL SCALE	WESTON MODEL		5
									6
									7
									8
				101-5030-971		LIGHT INDICATOR -RED	DIALITE		9
				CM3150 CM330		LAMP, INPADENSENT 14V			10
									11
				FHL18G2-2		FUSE HOLDER			12
				FHL18G2-3		FUSE HOLDER INDICATOR			13
				313.250		3AG FUSE, AMP 2	LITTLE FUSE		14
									15
				MS24524-26		ON-NONE-MOMENTARY ON	MIL-C-39500C		16
									17

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	DC TO DC POWER PROCESSOR CHASSIS ASSY	
		SHEET 1 of 3	

SYSTEMS 2444 REV. 10-77

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
1				91, F 148BJA		2800 μfd/55VDC			18
				91, F 148BJA		LOCATED IN POWER MODULE			19
				91, F 148BJA		LOCATED IN POWER MODULE			20
1				LP8A1L106K		10/75 CAPACITOR			21
1				LP8A		10/75 CAPACITOR			22
1				LP8A		10/75 CAPACITOR			23
1				LP8A		10/75 CAPACITOR			24
1				650B1C474J		.47 μf 200V POLY CAP			25
									26
									27
3000						INPUT FILTER INDUCTOR			28
5000						INPUT FILTER INDUCTOR			29
						INPUT FILTER INDUCTOR			30
1				L-1497		SHORTING INDUCTOR			31
1				L-1497		SHORTING INDUCTOR			32
1				L-1505		SATURABLE REACTOR			33
1				L-1505		SATURABLE REACTOR			34

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	DC TO DC POWER PROCESSOR CHASSIS ASSY	
		SHEET 2 of 3	

SYSTEMS 2444 REV. 10-77

CONFIGURATION				PARTS LIST					
QTY REQD	QTY REQD	QTY REQD	QTY REQD	PART OR IDENTIFYING NO.	CODE IDENT	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR MANUFACTURER	CKT REF	ITEM NO.
1				-1505		SATURABLE REACTOR		SR303	35
1				MA141D		MAGNETIC AMPLIFIER		MA301	36
									37
									38
									39
									40
1				NH-50-25Ω		25Ω 50W NON-IND RES	DALE	R301 R302	41
1				9992-0041239		SHUNT	WESTON	R303	42
				RNC55H492FR		49.9K, 1% 1/8W	MIL-R-55182	R304	43
									44
				STFF15DL		20A, 150V DIODE	SEMTECH	CR1	45
									46
2				M24308/1-1		9-SOCKET, SUB-MIN TYPE D CONV			47
2				M24308/3-1		9-PIN			48
5				M24308/1-3		25 - SOCKET			49
5				M24308/3-3		25 - PIN			50
									51

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH, CALIFORNIA

SIZE	FSCM NO.		REV.
A	11982	DC TO DC POWER PROCESSOR CHASSIS ASSY	
		SHEET 3 of 3	

SYSTEMS 2444 REV. 10-77

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